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PROGRESS REPORT ON A STUDY OF THE RELATION OF WEATHER CONDITIONS TO THE DEVELOPMENT AND ABUNDANCE OF THE COCONUT LEAF MINER AND ITS PARASITES

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Since the coconut leaf miners attracted the attention of people in coconut regions, their apparently sudden appearance in alarming numbers has been the subject of considerable speculation. This pest was first noticed in the latter part of 1929 in San Pablo, Laguna, after which an active campaign against it was started immediately. Within a short time the pest spread to the provinces of Batangas and Tayabas. Judging from its prevalence, it was already present in the groves for some time before its discovery. So far no record can be found of its being so serious and never before had the leaf miner been considered an important and serious pest of the coconut. The campaign against it lasted up to the latter half of 1931, and during all that time various degrees of infestation were recorded. At the end of 1931, although the pest was believed to be under control, a force was still maintained in Laguna to check any possible new outbreak of the pest, or of any other pest or disease. The personnel of the Bureau of Plant Industry in other provinces were also on the lookout for outbreaks in their respective districts.

In February, 1933, a definite program was outlined with the purpose of determining the causes of the recurrence of the pest

in certain parts of the coconut-growing provinces. Research centered in the influence of weather conditions on the abundance of the pest and its parasites. Because of lack of time and shortage of funds, the scope of the investigation was necessarily limited. It is hoped, however, that the data here presented will prove a fair start for future and more extensive work in this direction.

MATERIALS AND METHODS

Seven barrios of San Pablo, Laguna, fairly representative of the different degrees of infestation were selected for this observation. Each barrio was observed for one day of each week so that all of the seven barrios could be covered once every week. The following was the schedule of observations:

Concepcion	Saturdays
Del Remedio	Sundays
San Lucas	Mondays
San Pedro	Tuesdays
Sta. Isabel	Wednesdays
San Jose	Thursdays
San Gabriel	Fridays

Later, however, we found that the infestations in Concepcion, San Lucas, San Pedro, and Sta. Isabel were already negligible, so on April 23, 1934, new barrios which were more heavily infested were selected in their places. These were Sta. Veronica and San Crispin of San Pablo, and San Benito and San Agustin of Alaminos.

Four groves were selected in each barrio at the start and arrangements were made with the grove owners so that leaflets could be taken at random in said groves. Tables 1 and 1-A show the distribution of the groves used in this work. Ten trees were taken up a day from each of the different groves in the assigned barrio and 50 leaflets were, in turn, cut at random from each tree. This gave us a total of 500 leaflets from each grove or 2,000 leaflets from each barrio. For purposes of comparison, we divided the groves into two groups of two groves each. In one group parasites were liberated, while in the other groups no parasites were liberated. For obvious reasons, we made it a point to select groves that are very far apart and the two with the longest distance (about a kilometer) from each other were selected for the liberation of parasites. Hereafter, such groves will be referred to as the treated groves and the ones where no parasites were liberated as the control groves. Each grove con-

TABLE 1.—*Location of groves under study*

Days of examination	Barrios	Groves and owners	Remarks
Saturdays	Concepcion	I Benigno Reyes	Treated. [1]
		II Gil Exconde	Control. [2]
		III Enrique Bautista	Treated.
		IV Pedro Guia	Control.
Sundays	Del Remedio	I Jacinto Nicanor	Treated.
		II Pedro Ciabal	Control.
		III Narciso Gutierrez	Treated.
		IV Eladio Paulino	Control.
Mondays	San Lucas	I Victoria Gutierrez	Treated.
		II Marcos Alcantara	Control.
		III Florentino Mariño	Treated.
		IV Juan Briñas	Control.
Tuesdays	San Pedro	I Santiago Gutierrez	Treated.
		II Narciso Briñas	Control.
		III Juan Gutierrez	Treated.
		IV Lucio Funtanilla	Control.
Wednesdays	Santa Isabel	I Maximo San Pedro	Treated.
		II Raymundo Guia	Control.
		III Fausta Cornista	Treated.
		IV Patricia Reveza	Control.
Thursdays	San Jose	I Lorenzo Alimon	Treated.
		II Arsenio Exconde	Control.
		III Marcial de Luna	Treated.
		IV Marciano Arandia	Control.
Fridays	San Gabriel	I Saturnino Cortez	Treated.
		II Petronilo Fernandez	Control.
		III Juan Cruz	Treated.
		IV Crisanto de los Reyes	Control.

[1] Parasites were liberated in all treated groves.

[2] No parasites were liberated in all control groves.

sisted of at least 500 trees and about 2,000 larval parasites were liberated in each.

These parasites were first collected in test tubes in our laboratory in San Pablo and then liberated in treated groves as mentioned above. Egg parasites were liberated by means of cages. Leaflets with parasitized eggs were placed in these cages which were, in turn, placed in the treated grove. Hence, no actual count of the parasites was made. In spite of any degree of infestation in any or all groves under treatment, such groves were exempt from "las-las" (cutting off the infested leaflets). Hence, throughout this work the selected groves referred to above were never molested by the campaign. Egg parasites were liberated April 1, 1933, and larval parasites, May 6, 1933, when the first signs of larval infestation were noted. We did

TABLE 1–A.—*Location of groves under study*

Days of examination	Barrios	Groves and owners	Remarks
Saturdays	San Crispin	I Potenciano Malvar	Treated. [1]
		II Felipa de Mesa	Control. [2]
		III Zacarias Bondad	Treated.
		IV Consorcia Dichoso	Control.
Sundays	Del Remedio	As in Table 1	
Mondays	San Benito, Alaminos.	I Florencio Cuello	Treated.
		II Potenciano Malvar	Control.
		III Eriberto Reyes	Treated.
		IV Felipe Escueta	Control.
Tuesdays	San Agustin, Alaminos.	I Dionicio Belen	Treated.
		II Esteban Donato	Control.
		III Augusto Reyes	Treated.
		IV Evaristo Tolentino	Control.
Wednesdays	Santa Veronica	I Rufino Alcantara	Treated.
		II Lucas Guevarra	Control.
		III Prudencio Fule	Treated.
		IV Sergio Bonilla	Control.
Thursdays	San Jose	As in Table 1	
Fridays	San Gabriel	As in Table 1	

[1] Parasites were liberated in all treated groves.
[2] No parasites were liberated in all control groves.

not restrict our liberation to only one species of larval parasites, and although our larval parasites were not identified, we suspected that at least four species were used in this observation.

These parasites with which we worked were of the species reared during our first campaign against the pest in 1929 to 1931. The two egg parasites (the yellow species, *Centrodora* sp., Aphelininae and the dark bluish green species, *Achrysocharis promecothecae* Ferriere, Eulophinae, both of the family Eulophidae) were identified by Dr. Leopoldo B. Uichanco, of the College of Agriculture, University of the Philippines, and so with the small and most common species of the larval parasites, these identifications have been verified by Mr. Gahan of the United States Bureau of Entomology and Plant Quarantine. The most common larval parasite was identified as *Pleurotropis* sp., Entedinae, Entedontidae(5). Except for one species of larval parasite, their life histories could not be worked out for our attempts so far to induce these insects to lay eggs in the laboratory failed. Up to the present we know of two species of egg parasites and we have been able to distinguish at least three larval parasites. The bigger species of larval parasites, the life history of which has been already worked out, has been identified by Mr. Gahan as

Sympiesis sp., from specimens sent by the Administration to Dr. Harold Morrison, in charge of the Division of Insect Identification of the U. S. Bureau of Entomology and Plant Quarantine.

Daily temperature and rainfall records were kindly furnished us, upon request, by the San Pablo local observation unit of the Philippine Weather Bureau.

Weekly average infestation of the seven barrios under observation was taken and graphed.

To get the leaflets on time, we employed three laborers (later, these were reduced to two) to go out to the assigned groves and take the needed samples to our laboratory to be examined for eggs, larvæ, pupæ, and adults and for parasitism. For this purpose we employed a worker who had previously served in the campaign, trained in scouting work. The whole project was placed in charge of Mr. Marcos A. Vega, who was given definite instructions as to the object and procedure of the research. Occasionally, as time permitted, we helped in the examination of the leaflets. Mr. Felix D. Lazo, assistant agronomist in San Pablo, also helped a great deal in obtaining the data herein presented. Messrs. Fausto Villanueva and Felix Arriola also rendered valuable assistance in the preparation of the work.

DISCUSSION OF RESULTS

Results of our observations are presented in Tables 2, 2-A, 4, 4-A, 4-B, 4-C, 4-D, and 4-E. Records given in these tables are graphed together with the weather records (Table 3) for the corresponding periods (Charts 1, 2, 3, 4, 5, and 6) to show the relation, if any, between the two.

It can be judged from the graphs of the results so far obtained that, on the whole, there is to be seen some difference in the degrees of infestation between the treated and the control groves, especialy at the beginning of the work. From experience, however, we learned that groves where no parasites were liberated showed high percentages of parasitism sometime after the first days of the invasion by the pest. Even strictly isolated infestations showed signs of parasitism to a certain degree after the pest had persisted there for at least one generation. It is, therefore, evident that parasites are able to follow their host without aid, but such a natural course is so slow that man's help is often necessary to bring about the immediate restoration of the balance between the pest and its parasites, i. e., to bring the pest under control. In the present case, where almost all groves were infested to a greater or less extent and for some

time before the beginning of this work, dispersal of liberated parasites could not be limited only to the groves where they were set free so that, together with the parasites already in the groves, their distribution, at certain times, was almost uniform in the treated and control groves. This was especially true toward the middle and end of the observation period. Some treated groves for some time after the liberation of the parasites, even exceeded the control groves in the degree of infestation and some control groves exceeded the treated groves in parasitism. There is to be noted also a marked decrease in the degree of infestation in the area under observation towards the end of the study. As will be seen elsewhere in this report, more serious infestations were discovered in other parts of Laguna which spread to Tayabas and Batangas, but many such infestations seemed to be independent of the one we had been working on and which was made material for the present study. But there was every indication that the infestation within the area under study showed improvement as we progressed.

Before we go further, let us distinguish between the different broods of the pest within the time limit of the present observation. These are as follows:

First brood—April 21 to June 30	70 days
Second brood—July 1 to September 15	77 days
Third brood—September 16 to December 8	84 days
Fourth brood—December 9 to March 9	90 days
Fifth brood—March 10 to May 11	63 days

As the broods of the pest were overlapping, we were not able to draw a definite demarcation between broods, but the preponderance of new eggs was taken as an indication of the beginning of a new brood.

Tables 2 and 2-A and Chart 1 show that the liberation of egg parasites had a decidedly favorable effect on egg parasitism in a grove. In this stage of the pest, the advantage of parasite liberation is very much in evidence. For the first brood (April 21 to June 30) the average parasitized eggs for every frond in the treated groves was 119.459 as against 86.755 for the control groves. Those in the treated groves represent 19.31 per cent of the total eggs laid during the brood while those in the control represent 14.67 per cent. For the following brood, or 147 days from the start of our study, the corresponding figures were 86.577 and 84.537. They represent 21.84 and 20.14 per cent, respectively, of the total eggs laid in the treated and the

control groves. Whereas the difference in the parasitized eggs between the treated and control groves was 3.64 per cent for the first brood, the corresponding difference in the second brood was only 1.70 per cent. In the third brood, this difference was only 0.40 per cent. The following brood showed a difference of 2.23 per cent in favor of the treated groves but in the fifth brood (March 10 to May 11) the control groves showed greater egg parasitism (by 0.83 per cent). For lack of funds, observations on the sixth brood was not continued, so that we cannot include in the discussion of this report what data we gathered during this period, although there were indications of greater parasitism in the treated groves.

The foregoing results clearly confirm the statement made in the earlier part of this discussion with reference to the increase in parasitism in a grove where no parasites were previously liberated. Let us take the difference between the egg parasitism of the treated and control groves in the first and the second broods (3.64 and 1.70 per cent, respectively). And as we note the differences in the later broods, we find the tendency of parasitism to be the same. Although we are not yet sure as to the exact life history of the egg parasites, we are sure that they can multiply at least 6 times (the average number of parasites found in an egg is 3; and 2 generations of the parasites are possible within the incubation period of the eggs of the pest) before the leaf-miner egg hatches. Now, there are many factors, among them wind and the ability of the parasites themselves to fly far, which aid the parasite to spread. This perhaps accounts for the almost uniform parasitism in the treated and control groves in the succeeding broods of the pest.

With regard to the effect of temperature and relative humidity on egg parasitism, comparison of the egg parasitism mentioned in the preceding paragraph with the average temperature for the brood shows that they are inversely proportional. From the first brood down to the fourth, there was a steady increase in the percentage of parasitism of the egg, while there was a marked decrease in the average temperature. Then, parasitism went down from 36.94 and 34.71 per cent in the treated and control groves, respectively, of the fourth brood, to 22.71 and 23.54 per cent, respectively, of the fifth brood, while the temperature correspondingly rose from 26.12° to 28.78°C. There is also a slight correlation between egg parasitism and relative humidity. As we have no weather records for Decem-

ber for no observations were made in San Pablo during this month, we cannot safely make use of the average weather records in the period covered by our fourth broods, but on the whole, there can be noted a sign of direct correlation between egg parasitism and relative humidity. Table 4 shows a marked rise in egg parasitism from the first brood to the fourth, as well as a rise in relative humidity for the corresponding period. The tendency of parasitism to go down in the fifth brood is accompanied by a corresponding fall in the relative humidity for the same period. In nature, as represented by our control groves, the same tendency was noted.

Several reasons can be advanced to explain this: In the first place, heat directly affects the egg adversely. We dissected numerous eggs in the field with the contents of each crumpled and dried. It seems that high temperature and the accompanying low humidity induce excessive evaporation which proves detrimental to the eggs of the pest, reducing the food supply of the parasite eggs that may have been laid in these leaf-miner eggs. Even if these eggs were not parasitized, their drying due to these factors reduces the number of fresh eggs in a grove which also reduces the chance of the parasites to locate their hosts. Because the parasites feed on moisture on the leaflets or the nectar of the flowers of various plants, and since high temperature and low humidity prevent such accumulation on the leaflets of the coconut, the parasites were forced to leave the palm and to seek for food elsewhere. This may also account for their scarcity in the coconut groves, especially the clean ones, during hot days.

Also, high temperature and low humidity caused the blotch in the leaflet where the egg of the pest was laid, to become hard, so that it was difficult, if not impossible, for the parasite to insert its ovipositor and reach for the egg of the leaf miner. For the same reason, eggs of the parasites which were laid at the time when conditions were favorable, may hatch and reach maturity at a time when the temperature is high and humidity low, so that the leaf tissue immediately above the egg is hard, in which case the parasites died either because of the direct effect of heat or because the hardness of the dried portion of the leaflet rendered it impossible for them to make an exit hole. In this case they were trapped and died of starvation.

The effect of rain on the eggs is not clearly marked, although there is indication that rain tends to reduce the number of egg parasites. Chart 1 shows, in the first three broods of the

pest, the adverse effect of rain on egg parasitism. As the weather record for December was incomplete, that month is not included in our discussion. For the period beginning January 5, 1934, we find the same relation obtaining.

At about the beginning of April (week ending April 14), when the rain was slight (7.6 millimeters), the parasitism of the egg was high (262.688 to the frond for the treated groves and 172.363 to the frond for the control). Through May and June, there was a decided increase in rainfall (49.89 mm. and 20.58 mm. for weeks ending June 23 and 30, respectively), and conversely, the egg parasitism went down (66.306 to the frond for treated and 71.943 to the frond for control, respectively). Towards the end of July and the beginning of August when rainfall was heavy (99.7 millimeters for the week ending August 2), egg parasitism was very low (35.681 to the frond for treated and 25.731 to the frond for control). As the rain decreased by the end of August (44.9 millimeters for the week ending August 25), egg parasitism again increased (138.825 to the frond for treated and 115.812 to the frond for control). Most of the parasites at this time were already in the eggs of the leaf miners, so that intermittent heavy rains of September and October did not materially affect them and examination in the laboratory showed many of the eggs parasitized. Many of the eggs thus examined were attacked by fungus and many of them had dead parasites in them. This interference of the fungus with the proper development of the parasites was largely caused by the rain at about the beginning of October and is reflected in the lower parasitism at about the middle of October. When rain became scarce towards the end of October (13.4 millimeters for the week ending October 27) up to early November (58.9 millimeters for the week ending November 3 and 2.5 millimeters for the week ending November 10), parasitism of the egg again showed a tendency to rise (85.370 to the frond for treated and 84.600 to the frond for control for the week ending October 27; 90.090 to the frond for treated and 87.206 to the frond for control for the week ending November 3; and 107.838 to the frond for treated and 95.044 to the frond for control for the week ending November 10). By November 24, when the precipitation for the week ending on that date was 4.80 millimeters, the numbers of parasitized eggs to the frond were 123.975 for the treated and 135.032 for the control. From January 1 to March 30, 1934, when rainfall ranged from 0 to 24.10 millimeters, the parasitized eggs to the frond ranged from 41.940 to 95.337 for the treated

and from 10.499 to 76.500 for the control. Rainfall after this period up to the end of the present observation (June 29) ranged from 0 to 134.30 millimeters. The number of parasitized eggs to the frond for the corresponding period ranged from 4.680 to 54.090 for the treated and from 3.470 to 51.930 for the control.

Effect of weather conditions on the larvae and their parasites.—As was mentioned before, we liberated more than one species of larval parasites in each treated grove, as was the practice even during our campaign from 1929 to 1931. While the effect of such liberation was visible in the first instar larvæ as shown in Table 4–A, it was not evident in the succeeding instars. Our failure in obtaining the same results in the second and third instars as in the first instar may be explained by the fact that although *Pleurotropis* occasionally succeeded in parasitizing first instar larvæ, none of the progeny reached the adult stage and died with the host. The main reason for the failure of this parasite to multiply when its host is in the first instar is probably because several of such parasites are present in each leaf miner and ordinarily the parasites require more subsistence than can be had in a first-instar larva. Whether the presence of numerous larvae of the parasite in one host is due to the polyembryony of the parasite or to its ability to lay so many eggs at one time is not as yet known. But the fact that there are usually from 2 to 5 such parasites emerging from one host in the second instar and still more from that in the third instar is enough clue that this number of parasites requires more subsistence than can be had in a first-instar larva. It thus seems apparent that the liberation of *Pleurotropis* when the leaf miner is in the first instar is not advisable, unless overlapping generations exist in the groves where these parasites are liberated. On the other hand, the bigger parasite, *Sympiesis* sp., lays but one to four eggs on each leaf miner, and these upon hatching, need no more than what they can consume of their host. However, we cannot consider the other parasites thus liberated to have perished as we have no idea so far as to their life histories and behavior outside the body of the leaf miner. After our liberations, these parasites may have perished of hunger or may have found some alternate hosts (of which we know nothing) where they found subsistence until the desired stage of the leaf miner was reached.

Considering the effect of the different weather conditions on the larvæ and their parasites we noted a direct correlation be-

tween live leaf-miner larvæ and temperature, that is, the higher the temperature, the more live leaf-miner larvæ we found to the frond. During days of lower temperature we noted higher parasitism. Humidity exerted some influence on larval parasitism and its rôle in increasing larval mortality is much in evidence. We found this to be true for all larval instars. High humidity and high precipitation resulted seemingly in high mortality of the larvæ especially the younger ones. The comparative mortality by instars is as follows: for the first brood with 178.20 millimeters precipitation and 77.6 per cent humidity, the dead larvæ to the frond were 2.43 to 4.39 per cent for the first instar, 5.37 to 8.00 per cent for the second instar, and from 9.80 to 10.28 per cent for the third instar. For the next two broods when rainfall was 594.13 millimeters and 440.60 millimeters, respectively, while the humidity was 82.27 per cent and 80.62 per cent, respectively, larval mortality to the frond rose to from 27.58 to 71.30 per cent for the first instar, 2.04 to 62.37 per cent for the second instar, and from 16.72 to 40.38 per cent for the third instar. Younger larvæ were more susceptible to adverse weather conditions than the older larvæ. Many instances were noted in which larval blotches brought to the laboratory or examined directly in the fields were very wet, and their interiors almost filled with water. First-instar larvæ often succumbed to these conditions while more mature ones were observed to have been able to resist the water in their blotches until the time when this dried out, and then to continue to live normally. Although the weather records for the fourth brood are not complete, they show a very high percentage of mortality in the first-instar larvæ. The precipitation during this brood would probably be higher if complete records were available. At any rate, the same degrees of resistance were exhibited by the different instars. When precipitation and humidity diminished in the fifth brood larval mortality was also reduced. The tendency of these weather factors to rise in the sixth brood caused the larval mortality to mount also, although records in this brood were not complete. Rainfall and humidity had, to a certain extent, direct effect on the mortality of leaf-miner larvæ.

Effect of weather conditions on the pupæ and their parasites.—As far as present observations are concerned, the different weather conditions do not seem to exert much influence upon the pupæ. Table 4-D shows an increase in the percentage of the live pupæ to the frond for both the control and the

treated groves as the observations progressed. The highest percentage of live pupæ was from December, 1933, to the first week of March, 1934. The different weather records for this period, although incomplete, were incidentally lower than the corresponding records for the other broods. Lower temperature and less precipitation associated with high humidity may be favorable to the pupæ of the pest. On the other hand, lower temperature does not seem very favorable to the parasites of the pupæ, which also seemed to prefer lower humidity.

Effect of weather conditions in the adults.—The effect of weather on the adults could not be accurately ascertained in the present study as our operations were restricted to direct field operations where counts of the adults affected by weather could not be had as in the case of the immature stages which were all confined inside the leaflets. The figures in Table 4-E represent adults found inside the blotches when the leaflets were taken from the groves. These figures, meager as they are, tend to show that the adults are, to a certain extent, adversely affected by heat. In the first two and fifth broods which fell in the months with high temperatures (28.83° and 27.59°C., respectively), the percentages of dead adults inside the blotches were much higher (36.49 and 28.51 per cent, 22.51 and 28.05 per cent, and 21.27 and 22.73 per cent) than those in the third and fourth broods (3.18 and 0.40 per cent, and 14.24 and 3.61 per cent) which fell in the months with low temperatures (26.73° and 26.12° C., respectively).

These findings were corroborated by actual field observations. During the days when the beetles were ready to fly, we could find them swarming in open spaces and across fields early in the morning from about 6 A. M. to about 8 A. M. During this period, the atmosphere was cool and the sun's rays not hot. But after 8 A. M., toward noon and early afternoon, we noted no beetles flying in such places. And if close observations are made right on the grasses in these open areas, plenty of adult leaf miners will be found clinging to the blades of those plants. If they are disturbed they readily fall to the ground instead of flying; or, if they fly, they don't fly long. Also, during hot days, one can find dead adults along roads and especially near houses with galvanized iron roofing. Right on the roofs of such houses, plenty of adults were found dead. These were probably overtaken by heat while on flight, became exhausted, and fell there

where they were killed by the hot roofs. The same explanation may hold true for the adults found along roads in towns and in open spaces.

Effect of weather conditions on the duration of the broods of the coconut leaf miner.—Tables 4 to 4-E show a decided effect of temperature and relative humidity on the length of each of the five broods embraced by the present study. During the first brood from April 21 to June 30, or a period of 70 days, the average temperature was 28.83°C. and the relative humidity 77.67 per cent. The gradual lowering of the temperature in the next three broods (27.59°, 26.73°, and 26.12°C., respectively) accompanied by high relative humidity (82.27, 80.62, and 84.29 per cent, respectively), resulted in the gradual prolongation of the broods (77 days for the second, 84 days for the third, and 90 days for the fourth). The fifth brood which occurred during the warmer days of 1934 when the average temperature was 28.78°C. and the relative humidity, 78.63 per cent was much shorter than the preceding ones, being only of 63 days duration. The conclusion, therefore, that we can draw from these results, is that the higher the temperature with the accompanying lower humidity the shorter life cycle of the brood.

Economic application of the results.—The fact that the duration of the broods of the leaf miner was inversely proportional to the rise in temperature and directly proportional to relative humidity enables us to predict the duration of future broods, and to adjust our various means of control to destroy as many of the leaf miners as possible within the time limit of the brood. Since the larvæ were most affected by the weather in that the larval stage was longer during cool weather and shorter during hot weather, more labor should be employed and more parasites reared during hot days to keep pace with the development of the pest.

Moreover, since the parasite, *Sympiesis* sp., is most effective for the first instar and *Pleurotropis* during the succeeding instars, we can determine the species of parasite to be liberated at each point in the life cycle of the pest. Also, although they may exist in a given locality, their migration to the adjoining infested groves required considerable time; therefore, man labor should be employed to facilitate their transfer. A laboratory should be established for the study of the rearing and multiplication of the parasites to insure ready supply when the need arises.

SUMMARY AND CONCLUSIONS

1. There is some difference in the degree of infestation between the control and treated groves.

2. The parasites are able to follow their host without man's aid; but such a natural course is so slow that mass liberation is necessary to bring about the speedy restoration of the balance between the pest and its parasites.

3. The duration of the brood is directly proportional to the relative humidity and inversely proportional to temperature.

4. Egg parasitism is inversely proportional to the temperature and directly proportional to the relative humidity.

5. Although rain has no marked direct effect on the eggs, it tends to reduce the number of egg parasites. On the other hand, it had a marked adverse effect on the younger larval instars but none on the older, and on the pupæ.

6. Liberation of *Pleurotropis* when the host is in the first instar does not seem to be advisable except where the broods of the latter overlap. Survival of the parasites in the absence of suitable hosts in a locality has not been worked out.

7. The higher the temperature the more live larvæ were found to the frond and the less larval parasites.

8. High humidity and high precipitation were found detrimental to the first instar larvæ but not to older stages.

9. The higher the temperature with accompanying lower humidity, the shorter the brood.

10. When the temperature is high and relative humidity low, more labor is required and more parasites should be liberated to keep pace with the development of the pest.

TABLE 3.—*Weekly averages of humidity and temperature at San Pablo, Laguna, for 1933 and 1934*

Weeks ending	Average relative humidity	Average temperature	Total rainfall
	Per cent	°C.	*mm.*
April 14	60.10	28.38	7.60
April 21	70.36	28.70	1.30
April 28	72.21	29.27	12.70
May 5	75.14	29.20	17.30
May 12	70.14	29.64	4.36
May 19	74.42	29.46	6.19
May 26	74.93	29.13	25.37
June 2	87.75	28.40	15.73
June 9	74.58	29.50	10.74
June 16	83.75	28.90	15.34
June 23	81.10	28.12	49.89
June 30	82.67	26.70	20.58
July 7	80.57	27.60	51.68
July 14	79.10	28.80	26.17
July 21	76.79	28.50	29.19
July 28	83.75	26.83	68.92
August 4	93.60	27.00	99.70
August 11	81.17	27.40	60.20
August 18	79.71	27.30	24.30
August 25	79.86	28.00	44.90
September 1	79.33	27.90	20.00
September 8	84.10	28.30	34.70
September 15	88.00	25.86	196.40
September 22	88.20	26.15	14.00
September 29	81.30	27.36	71.60
October 6	78.50	27.10	95.30
October 13	82.60	25.92	148.30
October 20	75.40	28.22	27.70
October 27	81.10	27.12	13.40
November 3	79.90	26.96	58.90
November 10	76.30	26.10	2.50
November 17	77.80	27.50	2 60
November 24	82.80	25.33	4.80
December 1 (Records up to November 30 only)	82.87	26.26	1.50
January 5 (Records from January 1 to January 5 only).	80.60	26.80	0.00
January 12	80.50	26.80	1.60
January 19	82.00	26.70	8.50
January 26	95.60	23.20	15.10
February 2	87.70	25.50	3.10
February 9	91.80	23.80	2.10
February 16	76.70	24.90	4.30
February 23	87.30	25.40	24.10
March 2	77.90	28.10	4.50
March 9	82.80	27.00	0.50
March 16	79.60	29.30	6.60
March 23	77.90	27.40	3.50
March 30	84.30	30.00	0.00
April 6	81.50	27.60	134.30
April 13	79.00	27.40	33.70
April 20	78.00	28.90	0.00

TABLE 3.—*Weekly averages of humidity and temperature at San Pablo, Laguna, for 1933 and 1934*—Continued

Weeks ending	Average relative humidity	Average temperature	Total rainfall
	Per cent	°*C.*	*mm.*
April 27	75.80	29.50	6.10
May 4	75.40	29.80	0.00
May 11	76.20	29.10	59.10
May 18	81.00	27.80	97.10
May 25	89.40	26.60	55.60
June 1	79.90	29.20	21.00
June 8	81.00	28.40	24.90
June 15	79.90	28.50	27.60
June 22	78.40	28.40	18.80
June 29	81.10	27.50	27.30

296670—2

TABLE 4.—*Average number of eggs to the frond in relation to weather conditions.*

Broods	Groves	Hatched		Fresh		Parasitized		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent				
										°C.	mm.		Per cent
First, April 21 to June 30 (70 days).	Treated	57.267 (8.903)	9.26	33.979 (7.696)	5.49	119.459 (13.490)	19.31	408.031 (±15.346)	65.94	28.83	178.20	37	77.67
	Control	79.218 (±12.606)	13.40	48.357 (13.935)	8.18	86.755 (±9.254)	14.67	376.904 (±22.616)	63.75				
Second, July 1 to September 15 (77 days).	Treated	58.203 (±9.591)	19.69	43.044 (14.407)	10.86	86.577 (±6.212)	21.84	108.507 (±18.090)	52.61	27.59	594.13	54	82.27
	Control	84.928 (±13.652)	20.23	45.381 (±11.392)	10.81	84.537 (±8.081)	20.14	204.975 (±19.675)	48.82				
Third, September 16 to December 8 (84 days).	Treated	69.896 (±5.173)	20.91	28.106 (±3.770)	8.41	117.391 (±4.081)	35.12	118.903 (±7.403)	35.56	26.73	440.60	44	80.62
	Control	65.842 (±5.619)	19.57	24.889 (±3.352)	7.40	116.797 (±4.566)	34.72	128.850 (±4.728)	38.31				
Fourth, December 9 to March 9 (90 days).	Treated	36.083 (±3.494)	17.01	2.807 (±0.600)	1.32	78.365 (±3.878)	36.94	78.365 (±6.509)	44.73	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	35.007 (±3.170)	17.73	2.209 (±0.506)	1.12	68.524 (±5.329)	34.71	91.691 (±6.340)	46.44				
Fifth, March 10 to May 11 (63 days).	Treated	50.975 (±9.908)	28.54	16.765 (±11.716)	9.39	40.624 (±3.055)	22.71	70.223 (±8.344)	39.36	28.78	243.30	22	78.63
	Control	47.230 (±9.699)	29.43	14.091 (±7.278)	8.78	37.778 (±2.860)	23.54	61.401 (±7.685)	38.25				
Sixth, May 12 to June 29 (48 days, incomplete).	Treated	87.737 (±12.330	34.22	11.291 (±6.077	4.40	38.579 (±4.398)	15.05	118.787 (±12.013)	46.33	[b] 28.02	[b] 272.30	[b] 30	[b] 80.90
	Control	86.798 (±11.986)	35.06	10.836 (±5.079)	4.38	37.010 (±4.007	14.95	112.920 (±5.463)	45.62				

[a] No Records for December.

[b] Observations discontinued for lack of fund.

TABLE 4-A.—*Average number of larvae, first instar, to the frond in relation to weather conditions*

Broods	Groves	Alive		Parasitized		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent	Number	Per cent				
								°C.	mm.		Per cent
First, April 21 to June 30 (70 days)	Treated	20.215 (±9.551)	97.46	0.022 (±0.011)	0.11	0.504 (±0.115)	2.43	28.83	178.20	37	77.67
	Control	28.160 (±10.718)	95.59	0.006 (±0.027)	0.02	1.292 (±0.519)	4.39				
Second, July 1 to September 15 (77 days)	Treated	14.250 (±4.297)	51.61	2.547 (±1.379)	9.23	10.813 (±3.556)	39.16	27.59	594.13	54	82.27
	Control	27.403 (±2.880)	68.74	1.467 (±0.384)	3.68	10.995 (±2.516)	27.58				
Third, September 16 to December 8 (84 days).	Treated	9.572 (±1.673)	24.54	2.852 (±0.553)	7.31	26.580 (±1.261)	68.15	26.73	440.60	44	80.62
	Control	8.106 (±1.268)	21.81	2.562 (±0.580)	6.89	26.495 (±1.416)	71.30				
Fourth, December 9 to March 9 (90 days).	Treated	3.196 (±0.540)	14.09	2.257 (±0.290)	9.95	17.228 (±1.619)	75.96	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	3.421 (±0.567	15.95	2.094 (±0.250)	9.76	15.933 (±1.437)	74.29				
Fifth, March 10 to May 11 (63 days)	Treated	15.120 (±5.133)	49.23	1.882 (±0.331)	6.14	13.710 (±1.626)	44.63	28.78	243.30	22	78.63
	Control	19.098 (±5.841)	54.85	1.504 (±0.310)	4.32	14.215 (±2.030)	40.83				
Sixth, May 12 to June 29 (48 days, incomplete).	Treated	0.844 (±0.357)	2.73	1.645 (±0.250)	5.33	28.432 (±3.319)	91.94	[b] 28.02	[b] 272.30	[b] 30	[b] 80.90
	Control	1.102 (±0.398)	3.55	1.956 (±0.297)	6.30	28.007 (±3.420)	90.15				

[a] No records for December.

[b] Observations discontinued for lack of fund.

TABLE 4–B.—*Average number of larvae, second instar, to the frond in relation to weather conditions*

Broods	Groves	Alive		Parasitized		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent	Number	Per cent				
								°C.	mm.		Per cent
First, April 21 to June 30 (70 days)	Treated	13.120 (±3.669)	91.37	0.082 (±0.020)	0.57	1.158 (±0.344)	8.06	28.83	178.20	37	77.67
	Control	19.941 (±6.509)	92.20	0.526 (±0.304)	2.43	1.160 (±0.378)	5.37				
Second, July 1 to September 15 (77 days).	Treated	9.733 (±2.779)	80.13	0.371 (±0.088)	0.37	2.042 (±0.546)	2.04	27.59	594.13	54	82.27
	Control	13.523 (±3.548)	79.81	0.383 (±0.108)	2.26	3.039 (±0.782)	17.93				
Third, September 16 to December 8 (84 days).	Treated	6.647 (±1.754)	47.56	0.521 (±0.094)	3.72	6.808 (±0.938)	48.72	26.73	440.60	44	80.62
	Control	4.157 (±0.836)	34.91	0.324 (±0.047)	2.72	7.428 (±1.416)	62.37				
Fourth, December 9 to March 9 (90 days).	Treated	3.185 (±0.614)	45.44	0.175 (±0.034)	2.50	3.649 (±0.573)	52.06	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	3.097 (±0.567)	45.54	0.198 (±0.040)	2.91	3.505 (±0.526)	51.55				
Fifth, March 10 to May 11 (63 days)	Treated	8.908 (±3.973)	77.01	0.257 (±0.074)	2.22	2.402 (±0.465)	20.77	28.78	243.30	22	78.63
	Control	7.946 (±3.757)	80.17	0.286 (±0.061)	2.88	1.680 (±0.290)	16.95				
Sixth, May 12 to June 29 (48 days, incomplete).	Treated	12.917 (±6.441)	61.23	0.394 (±0.088)	1.87	7.784 (±1.275)	36.90	[b] 28.02	[b] 272.30	[b] 30	[b] 80.90
	Control	14.075 (±3.062)	61.38	0.390 (±0.061)	1.70	8.465 (±1.334)	36.92				

[a] No weather records for December.

[b] Observations discontinued for lack of fund.

TABLE 4–C.—*Average number of larvæ, third instar, to the frond in relation to weather conditions*

Broods	Groves	Alive		Parasitized		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent	Number	Per cent				
								°C.	mm.		Per cent
First, April 21 to June 30 (70 days)	Treated	12.703 (±4.425)	88.45	0.183 (±0.034)	1.27	1.476 (±0.594)	10.28	28.83	178.20	37	77.67
	Control	14.320 (±5.234)	88.80	0.221 (±0.054)	1.37	1.585 (±0.600)	9.80				
Second, July 1 to September 15 (77 days).	Treated	9.115 (±2.725)	76.94	0.100 (±0.027)	0.84	2.632 (±1.086)	22.22	27.59	594.13	54	82.27
	Control	11.280 (±2.941)	82.05	0.170 (±0.047)	1.23	2.299 (±0.573)	16.72				
Third, September 16 to December 8 (84 days).	Treated	5.599 (±1.889)	65.26	0.251 (±0.047)	2.93	2.729 (±1.018)	31.81	26.73	440.60	44	80.62
	Control	4.734 (±0.580)	58.57	0.085 (±0.013)	1.05	3.264 (±0.911)	40.38				
Fourth, December 9 to March 9 (90 days).	Treated	3.338 (±1.228)	68.68	0.044 (±0.010)	0.92	1.408 (±0.331)	29.39	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	2.858 (±0.526)	65.54	0.025 (±0.007)	0.57	1.901 (±0.391)	33.89				
Fifth, March 10 to May 11 (63 days)	Treated	2.352 (±0.742)	79.14	0.049 (±0.010)	1.65	0.571 (±0.182)	19.21	28.78	243.30	22	78.63
	Control	1.212 (±0.398)	69.94	0.014 (±0.005)	0.81	0.507 (±0.486)	29.25				
Sixth, May 12 to June 29 (48 days, incomplete).	Treated	27.385 (±7.932)	88.51	0.018 (±0.010)	0.06	3.537 (±0.816)	11.43	[b] 28.02	[b] 272.30	[b] 30	[b] 80.90
	Control	24.060 (±7.285)	88.25	0.064 (±0.155)	0.23	3.141 (±0.594)	11.52				

[a] No records for December.

[b] Observations discontinued for lack of fund.

TABLE 4–D.—*Average number of pupæ to the frond in relation to weather conditions*

Broods	Groves	Alive		Parasitized		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent	Number	Per cent				
								°C.	mm.		Per cent
First, April 21 to June 30 (70 days)	Treated	4.439 (±1.612)	68.61	0.228 (±0.067)	3.52	1.803 (±0.558)	27.87	28.83	178.20	37	77 67
	Control	6.816 (±2.718)	65.27	0.942 (±0.351)	9.02	2.685 (±0.857)	25.71				
Second, July 1 to September 15 (77 days).	Treated	5.046 (±1.376)	79.02	0.110 (±0.027)	1.72	1.230 (±0.425)	19.26	27.59	594.13	54	82.27
	Control	9.717 (±3.076)	82.06	0.089 (±0.020)	0.75	2.035 (±0.722)	17.19				
Third, September 16 to December 8 (84 days).	Treated	7.426 (±2.705)	85.68	0.040 (±0.018)	0.46	1.201 (±0.486)	13.86	26.73	440.60	44	80.62
	Control	6.215 (±2.071)	82.60	0.028 (±0.011)	0.37	1.281 (±0.627	17.03				
Fourth, December 9 to March 9 (90 days).	Treated	1.825 (±0.499)	92.03	0.010 (±0.005)	0.50	0.148 (±0.047)	7.47	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	2.011 (±0.634)	92.29	0.005 (±0.003)	0.23	0.163 (±0.040)	7.48				
Fifth, March 10 to May 11 (63 days)	Treated	2.034 (±0.506)	91.91	0.029 (±0.020)	1.31	0.150 (±0.101)	6.78	28.78	243.30	22	78.63
	Control	1.476 (±0.411)	89.67	0 (±0)	0	0.160 (±0.074)	10.33				
Sixth, May 12 to June 29 (48 days, incomplete)	Treated	5.610 (±1.976)	89.18	0.004 (±0.003)	0.06	0.677 (±0.290)	10.76	[b] 28.02	[b] 272.70	[b] 30	[b] 80.90
	Control	5.214 (±1.740)	90.63	0 (±0)	0	0.539 (±0.755)	9.37				

[a] No records for December.

[b] Observations discontinued for lack of fund.

TABLE. 4–E.—*Average number of adults of the frond in relation to weather conditions*

Broods	Groves	Alive		Dead		Temperature	Total precipitation	Number of days of rainfall	Relative humidity
		Number	Per cent	Number	Per cent				
						°C.	mm.		Per cent
First, April 21 to June 30 (70 days)	Treated	1.356 (±0.533)	63.51	0.779 (±0.236)	36.49	28.83	178.20	37	77.67
	Control	2.006 (±0.897)	71.49	0.800 (±0.270)	28.51				
Second, July 1 to September 15 (77 days)	Treated	1.491 (±0.553)	77.49	0.433 (±0.169)	22.51	27.59	594.13	54	82.27
	Control	1.803 (±0.782)	73.95	0.635 (±0.236)	26.05				
Third, September 16 to December 8 (84 days)	Treated	1.299 (±0.332)	96.82	0.029 (±0.015)	3.18	26.73	440.60	44	80.62
	Control	1.480 (±0.600	99.60	0.006 (±0.003)	0.40				
Fourth, December 9 to March 9 (90 days)	Treated	0.283 (±0.128	85.67	0.047 (±0.138)	14.24	[a] 26.12	[a] 63.80	[a] 25	[a] 84.29
	Control	0.187 (±0.216	96.39	0.007 (±0.001)	3.61				
Fifth, March 10 to May 11 (63 days)	Treated	0.211 (±0.128)	78.73	0.057 (±0.031)	21.27	28.78	243.30	22	78.68
	Control	0.136 (±0.061)	77.27	0.040 (+0.027)	22.73				
Sixth, May 12 to June 29 (48 days, incomplete)	Treated	1.880 (±0.877)	96.71	0.064 (±0.029)	3.29	[b] 28.02	[b] 272.30	[b] 30	[b] 80.90
	Control	2.113 (±1.025)	94.46	0.124 (±0.054)	5.54				

[a] No records for December.

[b] Observations discontinued for lack of fund.

STUDIES ON THE *SCLEROTIUM ROLFSII* SACC. ATTACKING TOMATO, PEANUTS, AND OTHER PLANTS IN THE PHILIPPINES [1]

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TWELVE PLATES AND TWO TEXT FIGURES

INTRODUCTION

The tomato, *Lycopersicum esculentum* Mill. and the peanut, *Arachis hypogaea* Linn. are some of the many economic plants of the Philippines often attacked by the well-known soil fungus, *Sclerotium rolfsii* Sacc. In the United States, especially in the southern part, the fungus has been reported causing serious damage on various economic, ornamental, and wild plants (2–7, 10, 12, 13, 15, 17–18). Recently, Weber (18) reported it severe on carrots in Florida and listed all known plants affected by it.

In the Philippines, this fungus is also a problem of no less importance in certain localities, and has been reported attacking various economic plants by Reinking (14), Atienza (1), Ocfemia (11), Fajardo (4), and others. In a survey made by the senior writer in certain provinces of Luzon Island, tomatoes, peanuts, or beans showed from a trace to 50 per cent infection in the field. In certain farms in Maraboc, Manaoag, Pangasinan Province, from 20 to 50 per cent of bearing tomato plants were infected or dead because of it, while in Binalonan and Umingan of the same province infection on tomato, peanuts, and eggplants in the field varied from 5 to 20 per cent. The fungus was also noted on various garden plants in the school gardens at San Carlos Farm School, Pangasinan Province; at Paniqui, and Moncada, Tarlac Province; at Central Luzon Agricultural

[1] This investigation was started in the Bureau of Science and continued in the Bureau of Plant Industry when the senior writer was transferred to the latter Bureau in 1933.

School, Muñoz, Nueva Ecija Province; and at Batac Farm School, Batac, Ilocos Norte Province. In the Trinidad Agricultural School, La Trinidad, Mountain Province, potatoes, tomatoes, cabbages, or beans, and other ornamental plants (4) are generally attacked.

In the Provinces of Laguna, Batangas, Rizal, Bulacan, and Bataan this fungus is also common in tomato, peanut, sweet potato, pineapple, or yautia plants (*Xanthosoma sagittifolium* Schott). In Los Baños and in Lilio, Laguna; Lipa and Balayan, Batangas; Pasig, Rizal; Calumpit, Bulacan; and Balanga, Bataan, it is generally noted in tomato and peanut plants. In some Chinese and other home gardens in Manila, peanuts, sweet potatoes, eggplants, peppers, and some ornamental plants may be found generally affected. In the markets of Manila, it may be found affecting gabi corms (*Colocasia antiquorum* Schott) and other vegetables. While this survey is limited in its scope, it is believed that, because of the generally warm climate of these Islands, the *S. rolfsii* Sacc. might be more widely distributed and dangerous to crops than here reported.

Since this fungus is known to attack many agricultural plants, (18) which are or can be also grown in the Philippines, and since the climate of the Philippines is generally warm for its continued activity, its economic importance can not, therefore, be overemphasized. A study on certain phases of cultural and biologic behavior of the fungus will be of great interest, and this paper presents the results so far obtained.

SYMPTOMS OF TOMATO PLANTS AFFECTED BY *S. ROLFSII*

The symptoms of various plants affected by *S. rolfsii* have already been described by other workers. A brief description of the symptoms on tomato, however, will be presented, since this is one of the important field fruit crops commonly affected by it in the Philippines.

The tomato is susceptible at any stage of growth and on any part of the plant which comes in contact with the soil. Young plants, however, are more susceptible and rapidly killed than full grown plants with woody stems; and mature plants which shade their stems are more apt to be infected than those which allow sunshine and circulation of air more freely. In the seedbed where the seedlings are very close together, the fungus spreads very fast, and causes them to "damp-off" rapidly, while

in the field this situation is not generally met. The lesion first shows water-soaked appearance but as the disease progresses, the tissues rot or collapse rapidly. When the main stem is infected it is girdled, or gets rotted, and the whole plant, irrespective of its stage of maturity, gradually dies within a few days. Where infection is on the leaves, fruits, or branches, only these parts will rot or die without necessarily killing the whole plant.

A plant once infected seldom, if ever, recovers from the disease. When the weather is hot and dry the disease progresses slowly, and the whole plant may produce fairly good crop during the season. If, at any time during the season, the weather becomes warm, moist, or rainy, and there is abundant moisture in the soil, the fungus again becomes active, and the infected plant sooner or later dies without bearing any fruit. When such an infected or dead plant is pulled up the stem just below the soil line will show the diseased tissues with varying degrees of rotting. On these tissues and on the surrounding soil are strands of white, thick mycelia or the small, circular light brown to brown sclerotia of the fungus, characteristic of the disease. (Plate 1, figs. 1, 2, 3, and 5.)

The symptom on the fruit is a typical rot. Fruits which come in contact with the soil or those kept in storage under moist and warm conditions are generally attacked. The lesions show water-soaked appearance, but as the disease progresses, the characteristic rot will develop, until the whole fruit is completely involved. From this rotted fruit, the characteristic mycelia or sclerotia of the fungus are also found. (Plate 1, fig. 4).

ISOLATION OF *S. ROLFSII* SACC.

S. rolfsii can be readily isolated in pure culture on any of the standard culture media, either by placing bits of previously surface sterilized infected tissues, by direct transfer of mycelia or sclerotia, or by first placing infected tissues on moist petri dishes at room temperature 28–32°C. and the aërial mycelia or sclerotia which develops after 2 to 4 days can be transferred directly with sterile forceps or needle into poured agar plates. (Plate 2.) The fungus in pure culture then after 2 to 3 days will produce aërial, cottony, white, rather coarse flocculent septate mycelia, and afterwards its numerous light brown to dark brown sclerotia measuring from 0.5 to 1.2 mm. or more in size are developed.

Using one of the methods mentioned above, *S. rolfsii*[2] from certain regions of the Island of Luzon were isolated and were studied as will be discussed below. For convenience, each isolation is referred to as "strain." Strain I is isolated from tomato from Binalonan, Pangasinan; Strain II, isolated from tomato from Sta. Cruz, Laguna; Strain III, isolated from peanut from Los Baños, Laguna; Strain IV, isolated from beans from Trinidad Valley, Mountain Province; Strain V, isolated from pineapple from Calawang, Laguna; Strain VI, isolated from peanut from San Carlos, Pangasinan; Strain VII, isolated from peanut from Batac, Ilocos Norte; and Strain VIII, an undetermined sclerotium-like fungus isolated from infected peanut from Lilio, Laguna. Various isolations of the fungus were also made from other regions of Luzon Island, but as they appeared identical to some of those mentioned above, they are omitted in the following studies.

PATHOGENICITY TESTS OF VARIOUS STRAINS

In series of infection experiments, the eight "strains" or isolations of *S. rolfsii* were found all pathogenic and cause infection or death on susceptible plants without intervention of wounds. Tomato, peanut, bean, pea, potato, squash, tobacco, corn, and ampalaya (*Momordica charantia*) plants growing in 8–inch flower pots were inoculated by placing near normal and wounded stem bits of mycelia from 3 days old colony of each strain. The plants were then kept moist on one side of the bench in the greenhouse. After 3 to 8 days or more the plants were already infected or dead depending upon the stage of maturity and succulence of the inoculated plants. On young tomato, potato, squash, pea, ampalaya and bean plants with succulent stem, infection and death were observed within 2 to 4 days; on peanuts and tobacco plants, because of their more woody stems, infection and death were delayed; and on corn, infection was limited to the leaf-sheat and none was killed after the end of the experiment.

These results were further confirmed when tomato, potato, and bean plants were planted in inoculated soil put in cylinders. Again these plants died within a few days showing that all are pathogenic and that these economic plants are equally susceptible to anyone of these "strains" or isolations of *S. rolfsii.*

[2] Some of the isolations are identical to the authentic culture of *S. rolfsii* from the University of Wisconsin and from the Florida Experiment Station. No doubt we have here in the Philippines the *S. rolfsii* fungus.

(Plate 3.) In this connection, sclerotia were produced by each strain on the infected region and on the neighboring soil. Strains I to VI, generally produced round to ovoid, light brown to dark brown sclerotia, ranging in size from 0.4 mm. to 1.0 mm. or more, Strain VII, produced ovoid, oblong to irregular, light brown to brown sclerotia, ranging in size from 0.4 mm. to 1.5 mm. or more, and Strain VIII produced pale pink to pink, ovoid, oblong to heart or top shape sclerotia, ranging from 0.5 mm. to 2.0 mm. or more in diameter. Using the sclerotia as a source of reisolation, the strains were again isolated in pure culture.

CULTURAL STUDIES OF VARIOUS "STRAINS"

The rate of growth on different culture media.—The various strains differ in their rate of growth when grown on various culture media. In the first series, four 9-cm. plates each containing 10 cc. of potato agar, malt agar, oatmeal agar, peanut agar, and cornmeal agar were inoculated with 3 mm. mycelial blocks from 4 days old colony of each strain. The plates were then incubated at 28–32°C. and the diametric growth were measured after 3 days. From Table 1 it will be seen that Strains I to VI showed more rapid growth than Strain VII and Strain VIII on all the media tested. Strains I to VI on potato agar, malt agar, oatmeal agar, and peanut agar covered the 9-cm. plates within 3 to 4 days, while Strain VII and Strain VIII failed to cover it even after 5 days when the final notes were made. On cornmeal agar, all the strains started to grow slowly, but, again the last two strains showed slower growth.

TABLE 1.—*The rate of growth of various S. rolfsii "strains" on different media*

Srains of *S. rolfsii*	Average growth after 3 days on various culture media				
	Potato agar	Malt agar	Oatmeal agar	Peanut agar	Cornmeal agar
	cm.	*cm.*	*cm.*	*cm.*	*cm.*
I	9.0	8.5	8.7	7.7	5.7
II	9.0	9.0	8.2	8.5	6.1
III	9.0	9.0	8.1	8.4	6.3
IV	8.5	8.6	9.0	7.1	5.3
V	8.7	8.5	9.0	7.9	6.4
VI	8.0	8.7	9.0	8.7	6.6
VII	7.4	6.1	6.8	6.1	5.3
VIII	7.5	8.3	5.4	6.7	5.0

The result above was confirmed in another trial where steamed rice, steamed cornmeal, and steamed oatmeal[3] were also used in addition to the five media mentioned above. In Fig. 1 is a graph representing the average growth of each strain after 3 days. *On*

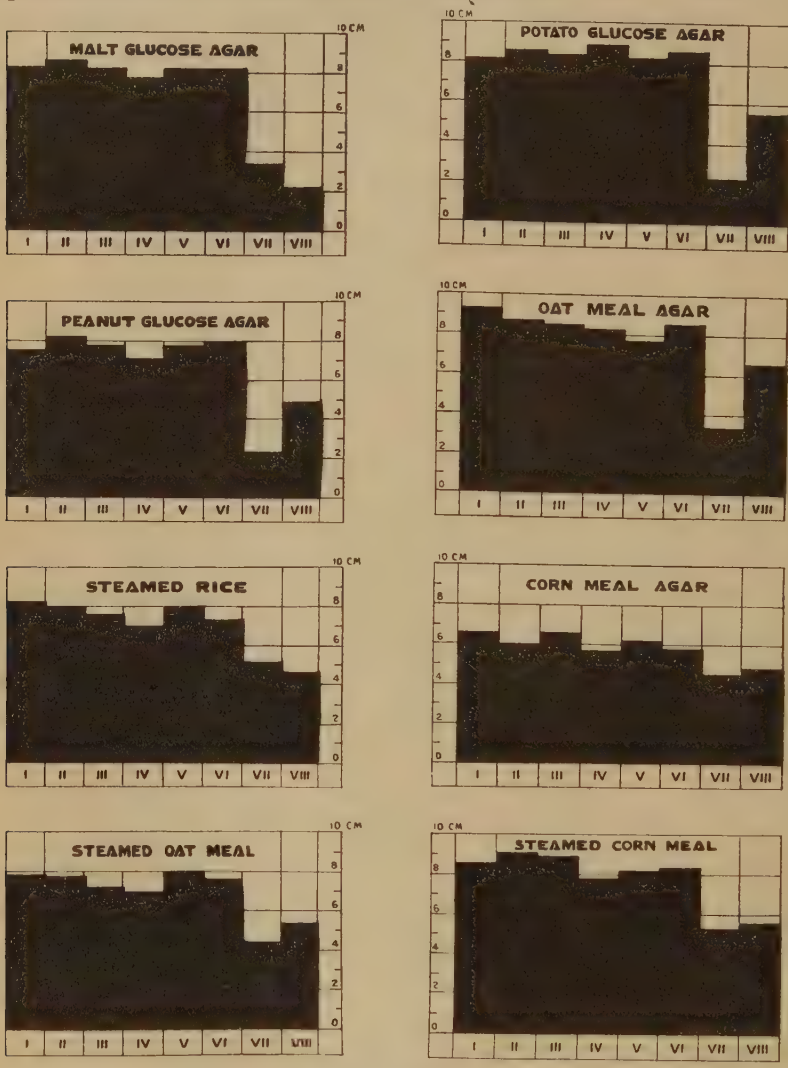

FIG. 1. The rate of growth of various strains on different culture media after 3 days at 28–30° C.

potato agar Strains I to VI made an average growth ranging from 8.1 to 8.8 cm *on malt agar* from 7.7 to 8.6 cm; *on oatmeal agar* from 7.8 to 9.3 cm; *on peanut agar* from 7.1 to 8.2 cm; *on*

[3] Five grams of each material and 10 cc. of water were placed to each petri dish and autoclaved at 20 lbs. pressure for 30 minutes.

cornmeal agar from 5.7 to 6.6 cm; *on steamed rice* from 7.0 to 8.3 cm; *on steamed cornmeal* from 7.8 to 8.9 cm; and *on steamed oatmeal* from 7.0 to 7.9 cm., respectively. Strain VII and Strain VIII, on the other hand made, respectively, an average growth of 2.2 and 5.5 cm. *on potato agar;* 3.4 and 2.4 cm. *on malt agar;* 3.4 and 6.6 cm. *on oatmeal agar;* 2.3 and 4.9 cm. *on peanut agar;* 4.5 and 4.9 cm. *on cornmeal agar;* 5.1 and 4.6 cm. *on steamed rice;* 5.3 and 5.6 cm. *on steamed cornmeal;* and 4.4 cm. and 5.4 cm. *on steamed oatmeal.*

In this connection, slight differences were noted in the density and type of colony produced by each strain. The relative density of growth of various strains as shown in Table 2 indicates that the best media for all the strains are steamed rice, steamed cornmeal, steamed oatmeal, and then followed by cornmeal agar, potato agar, peanut agar, malt agar, and oatmeal agar. The type of colony produced on these media varied slightly. When

TABLE 2.—*Density of mycelia produced on various culture media by S. rolfsii "strains" incubated at 28–32° C.*

Media used	*Sclerotium rolfsii* isolations [a]							
	I	II	III	IV	V	VI	VII	VIII
Potato agar	+++	+++	+++	+++	+++	+++	+++	++
Malt agar	++	++	++	++	++	++	++	++
Oatmeal agar	+	+	+	+	+	+	+	+
Peanut agar	++	++	++	++	++	++	++	++
Cornmeal agar	+++	+++	+++	+++	+++	+++	+++	+++
Steamed rice	++++	++++	++++	++++	++++	++++	++++	++++
Steamed cornmeal	++++	++++	++++	++++	++++	++++	++++	++++
Steamed oatmeal	++++	++++	++++	++++	++++	++++	++++	++++

[a] The symbols represent the density of mycelial growth. + poor to slight mycelial growth; ++ good mycelial growth; +++ very good mycelial growth; ++++ excellent mycelial growth.

the colonies are young, Strains I to VI on potato agar, malt agar, oatmeal agar, peanut agar, and cornmeal agar may produce colonies which are aërial to subaërial, fluffy to cottony, thick or thin colonies depending upon the media, while both Strains VII and VIII produced much coarser, fluffier, and thicker colonies. (Plate 4.) However, when the colonies becomes older some variations were noted. Strain VII become matted as Strains I to VI, but on the colony, thick or dense masses of mycelia are found from which the sclerotia may be produced. Strain VIII, on the other hand, besides producing aërial thready to cobwebby

mycelia, fails to produce its sclerotia freely on these media. (Plates 5 and 6.) On steamed rice, steamed cornmeal, and steamed oatmeal, all the strains made luxuriant and thick growth that in the early stages, it is very difficult also to distinguish the various strains. With age, however, not only differences in type of colony were noted but differences in the ability of certain strains to produce their sclerotia were also observed. (Plates 7 and 8.)

Time of sclerotia formation and number produced.—The number of sclerotia produced and the time of their formation varies with the different strains. In this experiment, four plates containing the same quantity of various media mentioned above were inoculated by each strain. All were incubated at 28–32° C., and the mature sclerotia from the plates were gathered and counted from time to time until sclerotia were no longer formed.

As shown on Table 3, Strains I to VI on potato agar, produced an average per plate from 363 to 626 sclerotia; on malt agar from 280 to 370 sclerotia; on oatmeal agar from 267 to 387 sclerotia; on peanut agar from 399 to 560 sclerotia; on cornmeal agar from 120 to 305 sclerotia; on steamed rice from 225 to 1,885 sclerotia; on steamed cornmeal from 332 to 4,402 sclerotia; and on steamed oatmeal from 582 to 2,783 sclerotia, respectively. Strain VII, on the other hand, produced an average per plate of 69 sclerotia on potato agar; 25 on malt agar; 32 on oatmeal agar; 42 on peanut agar; 25 on cornmeal agar; 40 on steamed rice; 50 on steamed cornmeal; and 82 on steamed oatmeal. With

TABLE 3.—*Average number of sclerotia produced by S. rolfsii "strains" on different media*

Media used	Average number of sclerotia produced by each strain [a]							
	I	II	III	IV	V	VI	VII	VIII
Potato agar	478	428	363	622	626	618	[c] 69	-------
Malt agar	280	345	289	347	282	370	[b] 25	[c] 4
Oatmeal agar	267	348	318	3 11	287	387	[b] 32	-------
Peanut agar	560	550	415	556	448	399	[b] 42	-------
Cornmeal agar	205	305	254	275	249	120	[c] 25	-------
Steamed rice	575	1,885	565	695	676	225	[b] 40	-------
Steamed cornmeal	4,402	2,098	630	1,573	2,383	332	[b] 50	-------
Steamed oatmeal	2,167	350	815	2,783	2,219	582	[b] 82	-------

[a] Average number of sclerotia from 4 plates.
[b] Counted after 30 days.
[c] Counted after 45 days.

the exception of malt agar, where two mature sclerotia [4] were noted, Strain VIII only produced either "sclerotia" "initial" or totally failed to produce them at all on the other media. (Plates 5, 6, and 8.)

In another trial, the various strains were grown on 5, 10, 15, and 20 cc. per plate of potato agar to determine whether Strain VII would produce sclerotia to equal any of the Strains I to VI. In this experiment, the number of sclerotia produced by each strain were increased with the increase in quantity of food material, but Strain VII again failed to produce as numerous sclerotia as Strains I to VI, and it did not induce Strain VIII to form its sclerotia. These results, therefore, show that Strain VII characteristically produce very few sclerotia as compared with Strains I to VI, while Strain VIII does not produce its sclerotia freely on these media.

In this connection, the time of formation of sclerotia varies with strains, and the duration of their formation is greatly influenced by the kind of media used. On potato agar, malt agar, oatmeal agar, and peanut agar, the sclerotia of Strains I to VI are nearly uniform in size and are produced singly near the edge or irregularly on the surface of the colony within 4 to 6 days. On cornmeal agar the sclerotia are delayed 6 to 8 days or more depending upon the strain. From all these media, the sclerotia are produced and matured nearly at the same time, that very few could be harvested from the second crop. On steamed cornmeal, steamed rice, and steamed oatmeal these strains generally produced their uniform to irregular size sclerotia within 8 to 10 days or longer depending upon the strain. The sclerotia on these media are produced either abundantly or scantily depending upon the strain and continued to be formed for some time making possible 3 to 4 different harvests from a single plate. Strain VII, on the other hand, produced its sclerotia within 8 to 10 days on potato agar, malt agar, oatmeal agar, and peanut agar; 10 to 12 days on cornmeal agar; and 10 to 15 days or longer on steamed cornmeal, steamed rice, and steamed oatmeal. This strain produced few sclerotia and that after the first harvest, very few could be gathered on the second crop. (Plates 5, 6, 8; Plate 9, fig. 1.)

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[4] These sclerotia before they matured sent out thick, straight, "comet-like" mycelial masses, a characteristic which was not observed in other strains.

The sizes of sclerotia produced.—The size of sclerotia produced also varies with the different strains. For this study, sample of air dry sclerotia of each strain produced at 28–32° C. from the experiments above were measured with a Vernier caliper.

As shown on Table 4 Strains I to VI on potato agar produced sclerotia ranging from .3 to 2.2 mm., mode of .8 to 1.0 mm., while Strain VII the sclerotia are from .5 to 2.2 mm., mode of 1.2 mm.; on malt agar the sclerotia of Strains I to VI ranges from .4 to 1.8 mm., mode of .8 to 1.0 mm., while Strain VII the sclerotia are from .6 to 4.2 mm., mode of 1.2 mm on oatmeal agar the sclerotia of Strains I to VI ranges from .4 to 1.7 mm., mode of .7 to 1.0 mm., while Strain VII the sclerotia ranges from .5

TABLE 4.—*The relative sizes of sclerotia produced by various "strains" of S. rolfsii.*

Media used		Sizes of sclerotia of various "strains"							
		I	II	III	IV	V	VI	VII	VIII
		mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Potato agar	Range	0.4–1.8	0.4–1.6	0.4–2.0	0.3–2.2	0.4–1.5	0.6–1.4	0.5–2.2	----------
	Mode	0.9	0.8	0.9	1.0	1.0	0.8	1.2	
Malt agar	Range	0.4–1.8	0.4–1.4	0.5–1.5	0.4–1.3	0.4–1.3	0.4–1.3	0.6–4.2	[a]3.0–5.0
	Mode	0.8	0.9	1.0	0.8	0.9	0.8	1.2	
Oatmeal agar	Range	0.5–1.7	0.5–1.6	0.5–1.5	0.5–1.6	0.4–1.4	0.5–1.4	0.5–3.2	----------
	Mode	1.0	1.0	1.0	1.0	1.0	0.7	1.2	
Peanut agar	Range	0.4–1.3	0.5–1.2	0.5–1.4	0.5–1.3	0.5–1.4	0.5–1.2	0.8–3.7	----------
	Mode	0.8	0.8	0.8	0.8	0.9	0.8	1.2	
Cornmeal agar	Range	0.5–2.2	0.4–2.7	0.4–1.9	0.8–3.5	0.6–2.2	0.4–2.2	0.8–3.9	----------
	Mode	1.0	1.0	1.0	1.2	1.2	1.0	1.3	
Steamed cornmeal.	Range	0.5–2.5	0.5–2.0	0.4–1.3	0.5–1.9	0.5–2.2	0.4–2.8	1.3–5.3	----------
	Mode	1.0	1.0	0.8	1.0	1.1	1.0	2.1	
Steamed rice	Range	0.6 2.2	0.8–2.7	0.7–2.5	0.5–2.3	0.7–2.7	0.6–1.4	0.6–5.4	----------
	Mode	1.0	1.0	1.0	1.0	1.0	1.0	1.5	

[a] Range of size of 5 sclerotia produced from 4 plates.

to 3.2 mm., mode of 1.2 mm.; on peanut agar the sclerotia of Strains I to VI ranges from .4 to 1.4 mm., mode .8 to .9 mm., while Strain VII the sclerotia ranges .8 to 3.7 mm., mode of 1.2 mm.; on cornmeal agar the sclerotia of Strains I to VI ranges from .4 to 3.5 mm., mode 1.0 to 1.2 mm., while Strain VII the sclerotia ranges from .8 to 3.9 mm., mode of 1.3 mm.; on steamed cornmeal the sclerotia of Strains I to VI ranges from .4 to 2.8 mm., mode .8 to 1.1 mm., while Strain VII the sclerotia ranges from 1.3 to 5.3 mm., mode of 2.1 mm.; on steamed rice the sclerotia of Strains I to VI ranges from .5 to 2.7 mm., mode 1.0 mm., while Strain VII the sclerotia ranges from 0.6 to 5.4 mm.,

mode of 1.5 mm. Strain VIII did not usually produce sclerotia but those five sclerotia produced from 2 plates on malt agar varies in size from 3.0 mm. to 5.0 mm.

From these results it will be seen that Strain VII produced a wider range and bigger mode size of sclerotia than Strains I to VI. On media rich in carbohydrates, i. e., steamed cornmeal, steamed rice, and steamed oatmeal the range in size of sclerotia of Strains I to VI were increased but they did not equal the sclerotia of Strain VII on same media. Plate 9 shows the sizes of sclerotia of Strains I, III, IV, VI, and VII on potato agar. On potato agar and malt agar, Strain VII showed a model size difference from Strains I to VI of 0.2 to .4 mm., on oatmeal from 0.2 to .5 mm., on peanut agar from 0.3 to .4 mm., on corn meal agar from .1 to .3 mm., on steamed cornmeal from 1.0 to 1.3 mm., and on steamed rice 0.5 mm. With the limited sclerotia produced by Strain VIII, this strain produced bigger sclerotia than Strains I to VI, and on malt agar, its sclerotia is bigger than Strain VII.

In this study, distinct differences were noted on the shape and other characteristics of the sclerotia. The sclerotia of Strains I to VI on potato agar, malt agar, oatmeal agar, and peanut agar are generally small, spherical, ovoid to irregular shape, but when grown on media rich in carbohydrates, i. e., steamed rice, steamed oatmeal, and steamed cornmeal the sclerotia may become ovoid to irregular shape, and may attain bigger sizes due to coalescence of two or more sclerotia. On such big irregular sclerotia, pits may be very evident. The sclerotia of Strain VII on any of these media are generally big, ovoid to irregular, and when the sclerotia coalesce they may attain various shapes from irregularly branched, kidney to sausage-shaped. (Plate 9, fig. 2.) The sclerotia of this strain are generally pitted but with the smaller ones, pits are less evident. With Strain VIII when its sclerotia are produced, they are either round, ovoid, irregular, heart to top-shaped and may also become pitted.

The color[5] *of the sclerotia.*—The color of sclerotia of various strains showed slight differences even when grown on different or on the same media. As shown on Table 5 of the sclerotia of Strains I, II, III, and VI on potato agar have generally snuff

[5] The color nomenclature is based from Ridgway's Color Standards and Color Nomenclature. 43 p., 53 colored pl., 1115 named colors. Washington, D. C. 1912.

TABLE 5.—*Comparison on the color of sclerotia produced by each S. rolfsii "strains."*

Media used	Color[a] of sclerotia of *S. rolfsii* "strains"							
	I	II	III	IV	V	VI	VII	VIII
Potato agar	Clay to snuff brown.	Clay to snuff brown.	Sayal brown to snuff brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Sayal brown to snuff brown.	Snuff brown to verona brown.	
Malt agar	Clay to sayal brown.	Sayal brown to snuff brown.	Clay to sayal brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Sayal brown to snuff brown.	Sayal brown to snuff brown.	Pale pink to pinkish color.
Oatmeal agar	Sayal brown to snuff brown.	Sayal brown to snuff brown.	Sayal brown to snuff brown.	Snuff brown to verona brown.	Verona brown to sepia.	Snuff brown to verona brown.	Snuff brown to verona brown.	
Peanut agar	Clay to sayal brown.	Clay to sayal brown.	Clay sayal to brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	
Cornmeal agar	Light clay to snuff brown.	Light clay to snuff brown.	Light clay to snuff brown.	Snuff brown to verona brown.	Sayal brown to verona brown.	Sayal brown to verona brown.	Snuff brown to verona brown.	
Steamed rice	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Sayal brown to snuff brown.	Snuff brown to verona brown.	
Steamed cornmeal.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	Snuff brown to verona brown.	

[a] From Ridgway's Color Standards and Color Nomenclature. 43 pp., 53 colored pl., 1115 named colors. Washington, D. C. 1912.

brown, while Strains IV, V, and VII have generally verona brown. On malt agar, Strains I and III have generally sayal brown; Strains II, VI, and VII generally snuff brown; and Strains IV and V generally verona brown. On oatmeal agar Strains I, II, and III have generally snuff brown; Strains IV, VI, and VII generally verona brown and Strain V generally sepia. On peanut agar Strains I, II, and III have generally sayal brown and Strains IV, V, VI, and VII generally verona brown. On corn meal agar, Strains I, II, and III have generally snuff brown and Strains IV, V, VI, and VII generally verona brown. On steamed rice, steamed cornmeal or on steamed oatmeal all the strains produced generally verona brown sclerotia.

From this result the color differences of sclerotia are not so marked to be significant in distinguishing one strain from another. In general, however, Strains I, II, III, and VI produced much lighter brown sclerotia on potato agar, malt agar, peanut agar, and cornmeal agar, and Strains IV, V, and VII produced slightly darker brown sclerotia on this media, but on media rich in carbohydrates Strains I to VII all produced identical color of sclerotia. Strain VIII differed from the rest of the strains in producing pale pink to pinkish color sclerotia as mentioned above.

Effect of temperature on rate of growth and formation of sclerotia.—Temperature affects the rate of growth, type of colony, and in time of formation of sclerotia of the various strains. In a series of studies, four plates containing 10 cc. potato agar for each range of temperature were inoculated with 3 mm. mycelial blocks of each strain. The plates were then incubated at the Bureau of Science with temperatures ranging from 6–8°C., 13–15°C., 18–20°C., 28–30°C., 33–35°C., and 43–45°C., and the average growth of each strain were made after 2, 4, 6, 10 and 14 days. Plates 10, 11, and 12 shows 4 and 14 days old colonies held at 13–15°C., 28–30°C., and 33–35°C.

From Table 6, it will be noted that growth was obtained between 13°C. and 35°C. but none was obtained at 6–8°C. and at 43–45°C. At 13–15°C. the rate of growth was very slow but continued for some time before the plates were completely ramified by fluffy aërial mycelia. After 14 days none of the strains covered the 9-centimeter plates. The colonies produced by Strains I to VII are thin with fluffy to cobwebby aërial mycelia, and Strain VIII showed also thin colony but are less aërial. Sclerotial formation by Strains I to VI was delayed 25 to 30

days, and were produced scantily, and that even in some plates no sclerotia were formed. Sclerotial formation of Strain VII was also delayed 15 to 20 days, while Strain VIII failed to form its sclerotia even after 35 days at this temperature.

At 18–20°C. all the strains made much faster growth than those observed at 13–15°C. After 4 days, the average growth was from 4.6 to 5.9 cm. and after 6 days all except Strain VII covered the 9-centimeter plate. The type of colony produced

TABLE 6.—*Comparison on the rate of growth of various S. rolfsii "strain" at different temperatures*

Temperature range and days observed	Rate of growth of various *S. rolfsii* "strains"							
	I	II	III	IV	V	VI	VII	VIII
At 6–8° C.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
2 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
4 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
6 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
10 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
14 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
At 13–15° C.								
2 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
4 days	0.9	1.5	1.3	1.2	1.0	1.0	0.8	0.3
6 days	3.0	3.7	4.2	3.7	3.1	2.5	2.0	1.8
10 days	5.5	5.5	5.4	6.1	6.0	5.1	4.0	2.7
14 days	8.3	7.8	8.3	8.8	8.8	8.3	7.5	6.8
At 18–20° C.								
2 days	2.4	2.5	2.4	2.4	2.4	2.2	2.1	2.2
4 days	5.6	5.9	5.8	5.8	5.6	5.8	4.6	5.7
6 days	***	***	***	***	***	***	8.0	***
10 days	***	***	***	***	***	***	***	***
At 28–30° C.								
2 days	4.2	4.0	4.7	4.5	4.7	3.2	2.8	2.6
4 days	***	***	***	***	***	***	8.5	***
6 days	***	***	***	***	***	***	***	***
At 33–35° C.								
2 days	2.5	2.9	3.3	3.1	3.1	2.2	1.6	1.0
4 days	5.6	5.9	8.9	7.3	7.1	3.6	3.4	3.7
6 days	***	***	***	***	***	5.5	5.2	6.7
10 days	***	***	***	***	***	8.4	6.8	***
14 days	***	***	***	***	***	8.5	7.0	***
At 43–45° C.								
2 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
4 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
6 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
10 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace
14 days	Trace	Trace	Trace	Trace	Trace	Trace	Trace	Trace

* * * Denotes that colony has already covered the 9-centimeter diameter of the petri-dish

by all the strains are aërial, fluffy to cottony mycelia, but Strains VII and VIII showed thicker and more creeping mycelia. Sclerotia formation by Strains I to VI were noted after 8 to 15 days and more numerous than those produced at 13–15°C. With Strain VII sclerotia formation was noted after 12 to 18 days while Strain VIII only showed "sclerotia initials" which never matured even after 30 days.

At 28–30°C. all the strains made very rapid, excellent, thick growth, and much better than at any other temperature. After 4 days, all the strains, except Strain VII covered the 9-centimeter plate. Slight differences in type of growth were noted. Strains I to VI produced thick, fluffy, cottony to dentritic or feathery colonies, while colonies of Strains VII and VIII were also thick, but their mycelia appeared thicker and coarser than Strains I to VI. At 14 days old, however, marked differences were noted. Strains I to VI have well matted colonies with their numerous sclerotia formed on the colony. Strain VII also has a matted colony like Strains I to VI, but on the colony are found thickened masses of mycelia in "tufts" from which sclerotia were being formed either singly or in groups. Strain VIII, on the other hand produced fine aërial mycelia which ramified all over the plate. Sclerotia formation by Strains I to VI was noted after 4 to 6 days; Strain VII after 8 to 12 days, while Strain VIII failed to produce its sclerotia. (Plate 11 and 12.)

At 33–35°C. all the strains showed slower and somewhat retarded growth than those observed from 28–30°C. After 4 days, the average growth was from 3.4 to 8.9 cm. and after 6 days Strains I to V covered the 9-cubic centimeter plate, while Strains VI, VII, and VIII failed to cover it, showing these strains grew more slowly at this temperature. The type of colony produced at this temperature varied somewhat on different strains. After 4 days Strains I to VI produced thin to thick aërial, flufiy to cottony colony; while Strains VII and VIII which grew very slowly gave a thick colony, with Strain VIII differing from Strain VII in producing thick straight mycelia and the presence of growth ring on the colony. After 14 days, Strains I to VI showed nearly identical matted colonies with abundant mycelia, while Strain VII gave irregular colony, with short, cottony to wooly whitish mycelia and failed to produce sclerotia. Strain VIII differed from the rest of the strains by producing a thin creeping colony with straight coarse mycelia. Sclerotia formation by

Strains I to VI was noted after 4 to 8 days while Strains VII and VIII failed to produce their sclerotia at this temperature.

At 6–8°C. and at 43–45°C. all the strains failed to grow. After 14 days, the plates were taken back at 28–30°C. and after 2 days at this temperature, those previously held at 43–45°C. failed to grow, while those previously held at 6–8°C. gave an average growth ranging from 4.2 to 5.8 centimeters and in a few more days produced their sclerotia, depending upon the strain. In further trials, it was found that the strains could be held at 6–8°C. for as long as 60 days, the longest period tried, without losing their viability, indicating that they were only checked in their vegetative growth at this temperature. Those held at 43–45°C. were greatly affected; after 3 days the colonies were so weakened, and after 4 to 5 days all the strains were dead. Trials were also made at 8–10°C. and found that growth continued very slowly and colony produced by Strains I to VII are aërial, fluffy to cottony, while Strain VIII produced thready-like mycelia on the colony. No sclerotia were produced by any strain even after 60 days.

From these studies it will be noted that the various strains have almost the same temperature requirements, but less active growth, few, if at all, sclerotic formation at lower temperatures, and faster, and more abundant and uniform growth, and earlier formation of sclerotia at higher temperatures. At 13–15°C. the rate of growth was slow and poor, better and faster at 18–20° C., best at 28–30°C. and somewhat retarded at 33–35°C. Figure 2 shows the average growth of various strains after 4 days at various temperatures. At 6–8°C. the fungus remained dormant as long as 60 days without any effect on their viability, while at 43–45°C. their viability was greatly affected, and after 4 to 5 days all the strains were dead. At 8–10°C. growth was obtained but all the strains were in mycelial stages. This result agrees with that of Harter(7) in his studies on the relation of temperatures to production of rots of aroids caused by a strain of *S. rolfsii.* Sclerotia formation by Strains I to VII is likewise influenced by temperature. At lower temperatures their formation was delayed or totally failed to appear but at higher temperatures with the exception of Strain VII at 35°C. Sclerotia were produced earlier and more abundantly by Strains I to VI. Strain VIII at any of these temperatures failed to produce its sclerotia. Basing on these results the optimum temperature for growth for all the strains is placed between 28–30°C., the maximum below 42°C., and the minimum slightly above 8°C.

Effect of temperatures on the germination of sclerotia.—The readiness of the sclerotia of the various strains to germinate is likewise influenced by temperature. In series of experiments, five sclerotia from 20 days old colony of each strain were sown per tube of two in a set containing 5 cc. of nutrient solution.

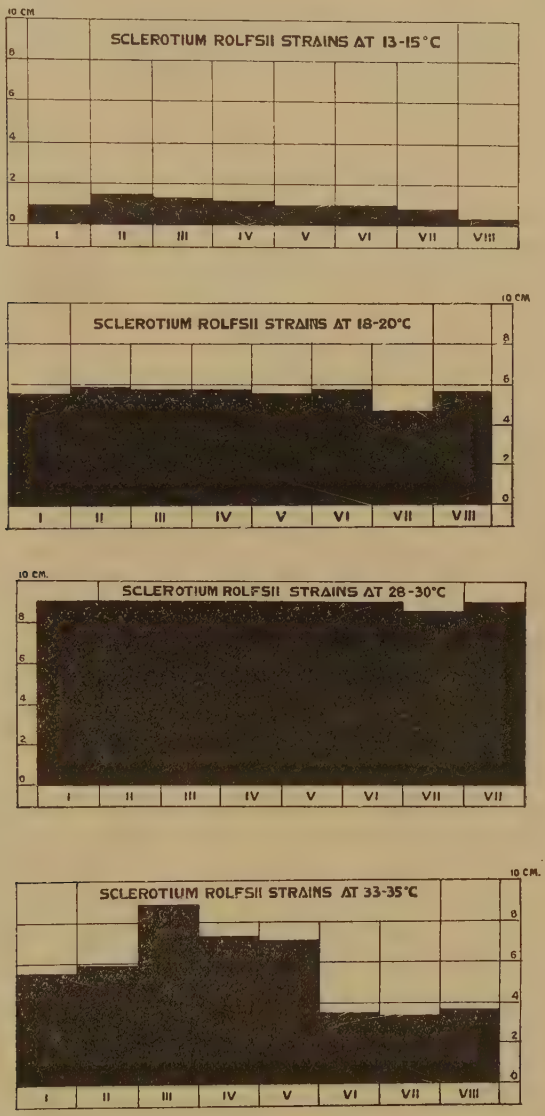
10 CM
SCLEROTIUM ROLFSII STRAINS AT 13-15°C
SCLEROTIUM ROLFSII STRAINS AT 18-20°C
10 CM.
SCLEROTIUM ROLFSII STRAINS AT 28-30°C
10 CM.
SCLEROTIUM ROLFSII STRAINS AT 33-35°C
10 CM.
I II III IV V VI VII VIII

FIG. 2. **Rate of growth of various strains at different temperatures after 4 days on potato agar.**

TABLE 7.—*Germination of 20 days and 90 days old sclerotia of various strains in nutrient solution of different temperatures.*

Temperature at which sclerotia are subjected	Number of hours observed	Per cent germination of 20 days old sclerotia (Series 1)							
		I	II	III	IV	V	VI	VII	VIII
6– 8°C	120	No germination after 120 hours							
13–15°C	12	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0
	48	0	0	0	0	0	0	0	0
	72	0	10	0	0	0	0	0	0
	96	40	10	0	0	20	20	10	0
	120	70	80	70	70	80	90	100	100
18–20°C	12	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0
	48	90	90	80	50	70	70	100	100
	72	100	100	100	100	100	100	100	100
28–30°C	12	0	0	0	0	0	0	20	0
	24	60	90	100	100	100	100	100	100
	48	100	100	100	100	100	100	100	100
33–35°C	12	0	0	0	0	0	0	0	0
	24	0	50	60	40	50	40	100	100
	48	100	100	100	100	100	100	100	100
43–45°C	120	No germination after 120 hours							

Temperature at which sclerotia are subjected	Number of hours observed	Per cent germination of 90 days old sclerotia (Series 2)							
		I	II	III	IV	V	VI	VII	VIII
6– 8°C	120	No germination after 120 hours							
13–15°C	12	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0
	48	0	0	0	0	0	0	0	0
	72	0	0	0	10	0	10	0	0
	96	0	0	0	10	0	10	0	0
	120	50	0	0	20	0	10	20	100
18–20°C	12	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	100	0
	48	50	10	60	10	60	80	100	100
	72	100	100	100	80	100	100	100	100
28–30°C	12	0	0	0	0	0	0	0	0
	24	70	30	70	70	80	60	100	100
	48	100	100	100	100	100	100	100	100
33–35°C	12	0	0	0	0	0	0	0	0
	24	80	40	70	80	100	90	80	100
	48	100	100	100	100	100	100	100	100
43–45°C	120	No germination after 120 hours							

With Strain VIII, which does not produce sclerotia freely, 3 mm. mycelial blocks from 3 days old colony were used. The tubes were then incubated at the same range of temperatures already mentioned above, and notes were made after 12, 24, 48, 72, 96, and 120 hours.

As shown on Table 7, series 1, the sclerotia failed to germinate even after 120 hours at 6–8°C. and at 43–45°C. At 13–15°C. the rate of germination was very slow; even after 72 hours 0 to 10 per cent germination was noted depending upon the strains. After 120 hours not all the strains gave 100 per cent germination. At 18–20°C. germination was much faster than those observed at 13–15°C. After 48 hours, from 50 to 100 per cent of the sclerotia germinated and after 72 hours all the strains gave 100 per cent germination. At 28–30°C. and 33–35°C., the germination of sclerotia was the best and earliest of all, as after 48 hours all the strains gave 100 per cent germination.

The above results were confirmed in a set of experiments where 90 days old sclerotia of each strain were tested, using the same stock of nutrient solution as above. Again, no germination was obtained at the lowest and highest temperatures, poor and slow at 13–15°C. and better at 18–20°C. and best at 28–30°C. and 33–35°C. (Table 7, Series 2). In these two series, differences were noted in the readiness of 20 days old and 90 days old sclerotia to germinate. The 90 days old sclerotia showed delayed germination at lower temperatures but at the favorable warm temperatures no difference was noted between the 20 and 90 days old sclerotia. Based on these results, no marked difference could be found between the strains in regards to temperature requirements for germination of their sclerotia and the optimum, maximum, and minimum temperature for sclerotia germination is identical as those temperatures already observed for vegetative growth and sclerotia formation mentioned above.

Germination of sclerotia in organic and inorganic solutions.— The sclerotia of the various strain germinated readily at certain concentrations of organic and inorganic solutions. In a set of experiments five sclerotia from 20 days old colony of each strain were placed to each tube in a set of four tubes, each containing 5 cc. of 1, 2, and 5 per cent glucose, sodium chloride, citric acid, and tartaric acid, and nutrient solution, tap and sterile water. As a check on the germinability, 10 sclerotia from the same

colonies of each strain were plated on the same day on poured potato agar. All were incubated at 28–32° C. and notes were made after 2, 4, 8, and 12 days.

As shown on Table 8 good an early germination was noted at the lower concentration of sodium chloride, citric acid, tartaric acid, glucose solution and on nutrient solution, tap water, and sterile water, while at higher concentrations of citric and tartaric acid, and on sodium chloride, germination was very slow and delayed. The differences noted in the percentage of germination at these various concentrations are considered not significant in distinguishing one strain from another. Fast germination was noted on 1, 2, and 5 per cent glucose, nutrient solution, and in 1 to 2 per cent citric and tartaric acid, while on tap water, sterile water or 2 per cent, 5 per cent sodium chloride, and 5 per cent citric and tartaric acid, germination was slow or delayed. In this connection the amount of mycelial growth varied in the different germinating media. The various solutions of glucose supported fairly good growth and poor to fairly good from various solutions of sodium chloride, 5 per cent citric and tartaric acid, and tap and sterile water. The best growth was obtained from nutrient solution and 1 and 2 per cent citric and tartaric acid.

STUDIES ON THE BIOLOGY OF *S. ROLFSII*

Viability of sclerotia on surface of dry and moist soil.—The sclerotia of *S. rolfsii* more readily germinate on the surface of moist soil than on the surface of dry soil. In a series of experiments, samples of sclerotia of Strains I and II were sown on surface of moist sandy and heavy soil placed in wire baskets. In order to keep the surface soil moist, the baskets were stood in a pan of water so that one inch of the bottom is immersed. Simultaneously with these experiments, samples of sclerotia were also sown on the surface of dry sandy and heavy soil. All were left at room temperature (28–32°C.) and the sclerotia which germinated were removed and counted from time to time until no further germination was observed.

From Table 9 it will be seen from the first series that most of the sclerotia germinated between the second to the fourth day, on the second series, germination continued to the eighth day; and on the third series, germination continued until the end of

[4] Unless otherwise stated only Strains I or II which are the most common strains of *S. rolfsii* isolated on tomato are used in the following studies.

TABLE 8.—*Germination of sclerotia of S. rolfsii on various organic and inorganic solutions*

Strains	Germinating solutions[a]														
	Glucose			Sodium chloride			Citric acid			Tartaric acid			Nutrient solution	Tap water	Sterile water
	1%	2%	5%	1%	2%	5%	1%	2%	5%	1%	2%	5%			
(*4 days*)															
I	40	60	40	60	0	0	100	100	40	100	100	0	100	20	40
II	100	100	100	100	100	100	100	100	0	100	40	0	100	80	100
III	100	80	100	100	100	0	100	80	0	100	100	0	100	80	60
IV	80	100	100	60	0	0	100	100	0	100	100	0	100	60	40
V	100	80	100	60	40	0	100	80	0	100	100	0	100	100	100
VI	100	100	100	100	40	0	100	100	0	100	100	0	100	100	60
VII	100	100	100	100	100	80	100	100	100	100	100	66	100	80	80
VIII	100	100	100	100	100	0	100	80	100	100	80	100	100	100	100
(*8 days*)															
I	100 (++)	100 (++)	100 (++)	80 (+)	0	0	100 (++++)	100 (++)	80 (++)	100 (++++)	100 (+++)	100 (+)	100 (++++)	60 (+)	100 (+)
II	100 (+)	100 (++)	100 (+)	100 (+)	100 (+)	100 (+−)	100 (++++)	100 (+++)	100 (++)	100 (++++)	100 (+++)	100 (++)	100 (++++)	80 (+)	100 (+)
III	100 (++)	100 (++)	100 (+)	100 (+)	100 (+)	60 (+)	100 (++++)	80 (+++)	100 (+)	100 (++++)	100 (++++)	66 (+)	100 (++++)	80 (+)	100 (+)
IV	100 (++)	100 (++)	100 (+)	60 (+−)	20 (+−)	0	100 (++++)	100 (+++)	100 (+)	100 (++++)	100 (+++)	100 (++)	100 (++++)	60 (+)	100 (+)
V	100 (++)	100 (++)	100 (+)	60 (+)	80 (+)	60 (+)	100 (++++)	80 (++)	100 (+−)	100 (++++)	100 (+++)	100 (++)	100 (++++)	100 (+)	100 (+)
VI	100 (++)	100 (++)	100 (+)	100 (+)	100 (+)	40 (+)	100 (++++)	100 (+++)	80 (+−)	100 (++++)	100 (+++)	100 (+)	100 (++++)	100 (+)	100 (+)
VII	100 (++)	100 (++)	100 (++)	100 (++)	100 (++)	80 (++)	100 (++++)	100 (+++)	100 (++)	100 (++++)	100 (++++)	100 (+)	100 (++++)	80 (+)	100 (+)
VIII	100 (+)	100 (+)	100 (+)	100 (+)	100 (+)	100 (+−)	100 (++++)	80 (++++)	100 (++)	100 (++++)	100 (+++)	100 (+++)	100 (++++)	100 (+)	100 (+)

[a] The symbol represents density of mycalial growth; + — very poor mycelial growth, + poor to fair mycelial growth, ++ good mycelial growth, +++ very good mycelial growth, ++++ excellent mycelial growth

TABLE 9.—*Germination of sclerotia on surface of moist sandy and heavy soil*

Strains used	Kind of soil used	Number of sclerotia started	Number of sclerotia germinated after, number of days											Total number of sclerotia germinated	Per cent germination	Total not germinated
			1	2	4	6	8	10	12	14	16	18	20			
Series 1																
Strain I	Sandy	50	------	14	12	------	------	------	------	------	------	------	------	26	52.0	[a] 24
	Heavy	150	------	35	110	------	------	------	------	------	------	------	------	145	96.6	[a] 5
Series 2																
Strain II	Sandy	250	46	164	17	5	1	------	------	------	------	------	------	233	93.2	[a] 17
	Heavy	200	22	86	45	33	2	------	------	------	------	------	------	188	94.0	[a] 12
Series 3																
Strain I	Sandy	200	2	3	15	36	39	------	16	24	22	23	------	180	90.0	[a] 20
	Heavy	350	5	14	140	85	17	2	23	19	15	5	------	325	92.8	[a] 25

[a] These sclerotia when surface sterilized, then plated on potato agar and incubated at 28–32° C. gave from 50 to 100 per cent germination, showing them still viable.

18 days, showing that in a sample of sclerotia which are in contact continuously on the surface of moist soil, that germination of sclerotia may be expected even until the 18th day or longer. In these series, the other sclerotia which failed to germinate on the surface of moist soil were found still viable and gave high percentage of germination when they were surface sterilized and were plated on potato agar. The sample of sclerotia left to germinate on the surface of air dry soil failed to germinate *in sitio*, even after 30 days. However, when sample of them were surface sterilized and were plated on potato agar, high percentage of germination was also obtained. The length of time that sclerotia may be kept on moist or dry soil and still remain viable was not determined, but it is believed they can resist longer periods, as field observations have shown that after few months of dry or rainy weather in the Philippines, sclerotia may be found to germinate readily as soon as favorable conditions are again present or when given suitable medium in the laboratory.

Viability of sclerotia in the soil.—The viability of sclerotia is greatly affected at certain depths they are buried in the soil. In a series of experiments, samples of sclerotia from Strain I were buried from 1 to 2 inches deep in moist soil put in wire basket which was stood in a pan of water so that one inch of the bottom is continuously immersed. Simultaneously with this series, samples of sclerotia were also buried 2 inches deep in a soil put in another basket which was completely immersed in water, so that the sclerotia were continuously flooded. After a certain number of days, samples of sclerotia were recovered, washed, surface sterilized, and then plated on poured potato agar. As shown on Table 10, Series 1, those buried 1 and 2 inches deep in moist soil for 40 days, gave 60 and 50 per cent viable sclerotia, respectively, while those buried 2 inches deep but flooded for 40 days gave 75 per cent viable sclerotia.

In another series, samples of sclerotia were buried at 1, 2, 3, 4, 5, and 6 inches deep in fairly moist soil placed in celluloid cylinders. After 5, 15, 30, 45, and 60 days, samples of sclerotia were recovered, surface sterilized, and plated on potato agar as before. The result which is summarized in Table 10, Series 2, shows that the sclerotia may be buried 4 inches deep in fairly moist soil for 60 days with only slightly affecting their viability giving still 60 per cent germinable sclerotia. Those buried 5 and 6 inches deep greatly affected their viability, as after 45 and

60 days those buried at 5 inches deep gave 10 per cent and 15 per cent viable sclerotia, respectively, while those buried at 6 inches deep for 45 and 60 days gave 0 per cent viable sclerotia.

From these results it will be seen that the scletoria may be buried 4 inches deep in moist soil for 60 days or buried 2 inches deep in flooded soil for 40 days, the longest period tried, without affecting their viability greatly, while those buried 5 and 6 inches deep showed a great reduction of viability after 45 or 60

TABLE 10.—*Viability of sclerotia in the soil*

Condition of soil	Dept of scloretia	Number of days	Number of sclerotia plated	Number of sclerotia germinated	Per cent germination
Series 1					
Moist	1 inch	5	25	22	88
Moist	1 inch	20	37	19	51
Moist	1 inch	40	20	12	60
Moist	2 inches	5	75	72	96
Moist	2 inches	20	35	14	40
Moist	2 inches	40	20	10	50
Flooded	2 inches	6	46	44	96.5
Flooded	2 inches	14	20	16	80.0
Flooded	2 inches	24	20	9	45.0
Flooded	2 inches	40	24	18	75.0
Series 2					
Moist	1 inch	30	10	10	100
Moist	1 inch	45	10	9	90
Moist	1 inch	60	10	10	100
Moist	2 inches	30	10	10	100
Moist	2 inches	45	10	9	90
Moist	2 inches	60	10	10	100
Moist	3 inches	30	10	10	100
Moist	3 inches	45	10	4	40
Moist	3 inches	60	10	7	70
Moist	4 inches	30	10	10	100
Moist	4 inches	45	10	5	50
Moist	4 inches	60	10	6	60
Moist	5 inches	30	10	10	100
Moist	5 inches	45	10	1	10
Moist	5 inches	60	20	3	15
Moist	6 inches	30	10	10	100
Moist	6 inches	45	10	0	0
Moist	6 inches	60	10	0	0

days. The time limit in which the sclerotia may be buried in flooded or moist soil and still retain its viability was not determined. Tisdale(17), however, found that the sclerotia of *S. rolfsii* from rice gave 100% viable sclerotia even after continuously immersing them in water in the laboratory or in the field for over 3 months. Unless other factors play in reducing the viability of the sclerotia in the soil, our rainy season in the Philippines perhaps is not long enough to completely kill all the sclerotia in the soil as the fungus reappear in the same piece of land or in the same locality from one year to another.

Depth in which the fungus is buried in relation to infection.—Taubenhaus(15) found that for successful inoculation it is necessary to cover the fungus not more than ½ to 1 inch deep, and no infection is possible if either the mycelium or sclerotia are buried more than 5 inches deep. Atienza(1) in his stuides on sclerotium disease on tomato and pepper found that sclerotia buried deeper than 1.5 cm. deep only showed 15 per cent infection.

In our studies young tomatoes were planted in a soil put in cylinder where the sclerotia and mycelia of 5 days old colony were placed on the surface and at 1, 2, 3, 4, 5, and 6 inches deep. Rapid infection and death of plants were observed after 2 to 5 days where the sclerotia and mycelia were on the surface or buried 1 inch deep. Delayed infection was noted where the fungus was buried 2 inches deep and the infection of 2 plants out of 5 under observation resulted only where the fungus followed up the loose soil near the edge of the cylinder and came to the surface. No infection resulted where the sclerotia or mycelia were buried 3, 4, 5, and 6 inches deep even after 25 days when the observations terminated. The results, therefore, show that the fungus is very active and readily caused infection when it is near the surface but may become inactive and incapable of infecting susceptible plants when buried 2 to 6 inches deep unless brought toward the surface by cultivation or other means. Plate 3 shows the result of these infection experiments four days after inoculation.

Longevity of sclerotia and mycelia in the laboratory.—Tisdale(17) finds that the sclerotia of *S. rolfsii* from rice kept in a dry condition for 9 months germinated readily when placed under proper conditions of moisture and temperature. Thompson(16) also states that one year old culture placed in water until swollen failed to germinate when placed on tubers, but when they were removed and placed on maize agar, growth occurred

and on inoculation caused the tubers to rot. Higgins(8) also finds that the sclerotia of *S. rolfsii* kept in dry test tubes germinate readily on fresh media when two years old.

In our test on longevity of sclerotia in the laboratory, 7 months old sclerotia gave 100 per cent germination, while those of 8, 12, and 16 months old gave 75, 20, and 0 per cent germination, respectively. In another set, sample of sclerotia varying in age from 7, 9, 12, 14, 16, and 18 months old colonies of *S. rolfsii* from tomato, rice, and pepper were plated on potato agar and incubated at 28–32°C. Those from 7 to 9 months old sclerotia gave high per cent germination while those from 12 months old gave from 5 to 20 per cent germination depending upon the strain. After 14 months, however, the germination of sclerotia from tomato was reduced to 1.7 per cent, and the pepper and rice strain both gave 0 per cent. After 16 months all the sclerotia from these strains were dead, showing that the common strain of *S. rolfsii* in the Philippines may be greatly reduced in viability after 12 to 14 months in the laboratory, and after 16 motnhs they are dead. (Table 11.)

TABLE 11.—*Viability of sclerotia under dry condition in the laboratory*

Age of sclerotia	Tomato		Pepper		Rice	
	Number of sclerotia plated	Per cent germination	Number of sclerotia plated	Per cent germination	Number of sclerotia plated	Per cent germination
Month						
7	40	100.0	20	100	20	100
9	40	22.5	20	25	20	50
12	40	5.0	20	20	20	5
14	57	1.7	20	0	20	0
16	40	0	20	0	20	0
18	40	0	20	0	20	0

Tests were also made on the viability of mycelia in the laboratory. In a series of experiments bits of aërial mycelia adhering on the side of culture tubes from 5 and 7 months old colonies when plated on potato agar were found still viable, but those from 8 or 10 months old were dead. Mycelia in blocks cut from 3 days old colony when allowed to dry separately in petri dishes in the laboratory were found to die sooner than those cultures kept in test tubes. The results, therefore, show that the mycelia of the fungus lose their viability sooner in the laboratory than the sclerotia.

Thermal tolerance of sclerotia and mycelia.—The sclerotia is more tolerant at higher temperatures than the mycelia of the fungus. In this experiment, mycelia in 3 mm. blocks from 3 days old colony and samples of sclerotia from 20 days old colony were heated at various length of time in test tubes containing 10 cc. of warm water heated at 48–50°C., 50–52°C., and 60–62°C. In order to keep the temperature of the water in the test tubes uniform, they were heated in a water bath which was constantly stirred. Previously, either the mycelia or sclerotia were dropped, reading of the temperature was made before and during the treatment. After the treatment, the test tubes were immersed in cold water, or sterile cold water was added. The mycelia or sclerotia were plated on potato agar and incubated at 28–32°C. for 3 days. As shown on Table 12 the mycelia were killed after 3 minutes exposure at 48–50°C., while the sclerotia withstood it even as long as 7 minutes giving 6 per cent germination. At 50–52°C., the mycelia were killed after 3 minutes, while the sclerotia withstood 5 minutes and gave 30 per cent germination, but, after 10 minutes, all were also killed. At 58–60°C. and at

TABLE 12.—*The viability of mycelia and sclerotia of S. rolfsii at various temperatures*

Temperature range	Duration of exposure	Number of mycelial blocks plated	Per cent germination	Number of sclerotia plated	Per cent germination
	Min.				
48–50°C.	1	10	100	20	100
	2	10	100	20	100
	3	10	0	20	50.0
	4	10	0	18	83.3
	5	----------	----------	20	50
	6	----------	----------	20	50
	7	----------	----------	30	6.66
	8	----------	----------	20	0
50–52°C.	1	5	100	20	100
	2	5	20	20	100
	3	5	0	20	100
	5	----------	----------	20	30
	10	----------	----------	20	0
58–60°C.	1	10	0	19	84.21
	2	10	0	19	84.21
	3	----------	----------	20	80
	4	----------	----------	20	30
	5	----------	----------	20	0
	6	----------	----------	20	0
60–62°C.	1	10	0	10	30
	2	----------	----------	20	0
	3	----------	----------	20	0

60–62°C., the mycelia were all killed after 1 minute exposure, while the sclerotia at 58°–60°C. were killed after 5 minutes exposure, and at 60–62°C. they were also killed after 2 minutes exposure, showing that the sclerotia are more tolerant to heat than the mycelia.

RELATIVE SUSCEPTIBILITY OF TOMATO VARIETIES

As discussed above, the various "strains" are all equally aggressively pathogenic on tomato and other economic plants. Test was made to determine the relative susceptibility of certain commercial American and native tomato varieties. For this purpose, Strain I, which is a common strain isolated from tomato and from peanut was used. Twenty-five to 30 days old seedlings growing in 8-inch pots were inoculated in the greenhouse, by placing the inoculum near the stem of one plant in the center of the pot. The plants were then enclosed in celluloid cylinders, the top of which was left uncovered and kept moist by sprinkling water from time to time. As shown in Table 13 the va-

TABLE 13.—*Relative susceptibility of commercial tomato varieties to S. rolfsii (Strain I)*

Variety name	Number of plants inoculated	Number of plants infected	Per cent infected
Acme	40	4	10.0
Beef Steak	31	11	35.5
Bonny Best	44	14	31.8
Break O'Day	32	23	[a] 71.8
Burpee's Fordhook First	31	8	25.8
Burpee's Matchless	32	29	[a] 90.6
Burpee's Self-pruning	22	8	36.3
Burpee's Tangerine	26	20	[a] 76.9
Chalk's Early Jewel	52	20	38.5
Dwarf Stone	46	4	8.7
Early Detroit	39	15	38.2
Giant Ponderosa	15	2	13.3
Golden Queen	33	21	63.6
Greater Baltimore	62	4	6.5
Gulf State Market	38	30	[a] 78.9
Gulf State Market	35	32	[a] 91.4
June Pink	25	9	36.0
Penn State Earliana	31	21	67.7
Stone	46	40	[a] 87.0
Strawberry or Husk	36	18	50.0
The Burpee	21	1	4.8
Trucker's Favorite	39	27	69.2
True Giant Ponderosa	39	9	23.1
Whole Salad	13	11	[a] 84.5
Native (Pasig)	25	15	60.0
Native (Calumpit)	25	20	80.0

[a] All the plants from these varieties later died.

rieties are all susceptible, but variation in susceptibility was noted depending upon the different varieties. The Burpee, Greater Baltimore, Dwarf Stone, and Acme were less affected. The fungus on these varieties spread slowly affecting only few plants after the end of the experiment. The other varieties which are more susceptible showed many dead plants within a few days, and on these dead plants abundant sclerotia were produced.

DISCUSSION

The fungus *S. rolfsii* is also a common soil parasite attacking tomato, peanut and other economic ornamental and weed plants in the Philippine Islands. In other countries, biologic strains or forms have been found or recognized by certain writers(3) (16). In the Philippines, the eight isolations of *S. rolfsii* on different hosts from different regions of Luzon Island which were studied culturally have shown three distinct "strains" or forms which might be distinguished from each other by differences in the rate of growth, type of colony, time of sclerotia formation, and in the number, size or color of sclerotia produced.

Strains I to VI, which were isolated on either tomato, peanut, bean or pineapple showed slight differences in their morphology and are considered identical or the same strain. Strain VII might be distinguished from Strains I to VI in being slow grower, produces thicker, coarser, or fluffier mycelia, and few, big sclerotia which are formed much later than Strains I to VI at ordinary temperatures. At 33–35°C. this strain failed to produce its sclerotia, while Strains I to VI at this temperature produced abundant sclerotia. Strain VIII is also a slow grower, but differed from Strain VII Ior from the rest of the strains, not only in the type of colony, but also in not producing its sclerotia freely in culture at any temperature to which it was subjected. The distribution of these last two strains is not so wide as those of Strains I to VI. Strains I to VI are generally found in most of the agricultural provinces of Luzon, and in the important truck farming region of Trinidad Valley, Mountain Province. Strain VII was isolated from Batac, Ilocos Norte, in Northern Luzon, and Strain VIII was isolated at the foot of Mount Banahaw, Lilio, Laguna, in Southern Luzon. Even if extensive cross inoculation tests are lacking to determine physiological differences, if any, the morphological differences of these three "strains" or forms are so distinct, and suffice that they are all aggressively parasitic on our economic plants of the Philippines.

These strains have almost identical temperature requirements, and why this is so can not be explained at this time. The results, however, indicate that any of these strains will survive our minimum or maximum temperatures, and even in Baguio, or Trinidad Valley, Mountain Province, where the temperature may reach as low as 6° to 10°C. for a few days during the year. Therefore, unless other factors check their viability or increase in the soil, they will remain either as mycelia or sclerotia in the soil, and continuously become a serious agricultural problem every year.

No experiments were undertaken on the control of the disease, but, certain precautionary measures based on the biology of the fungus will greatly reduce the disease in the field. The fungus is very actively parasitic when it is near the surface of the soil, and when there is abundant moisture. Plowing infested field 4 to 8 inches deep or more, regulating the amount of moisture sufficient to support normal growth of plants, or timing the season of planting will greatly reduce the loss which might be due to the disease. The fungus is carried from one place to another either with infected seeds, tubers, seedlings or with the soil. Care should, therefore, be taken to avoid its introduction to new fields by using only disease-free seeds, tubers, and uninfected seedlings, and if necessary, these propagative parts may be disinfected or immersed in hot water, the temperature and duration of exposure should vary in each particular case. Infected plants in the field should be dug up including the soil surrounding it and removed and burned. For small garden plots, or potted soil which are infected, sterilization by "firing," by chemicals, or by changing the infected soil with fresh uninfected soil is very desirable. The selection of resistant plants to control the disease is feasible, but it takes time. In view of the possible presence of biologic strains, development for resistance should be done locally. So far, no chemical is known to completely control the disease.

SUMMARY

1. The fungus *S. rolfsii* is a common soil parasite attacking tomato, peanut, and other economic as well as ornamental plants in the Philippines. The loss owing to it varies with the locality and the kind of crop affected.

2. The symptom of tomato plant affected by *S. rolfsii* is briefly described.

3. Eight different isolations of *S. rolfsii* from different regions of Luzon Island are all aggressively parasitic on most of our economic plants. No attempt was made to find the host ranges of each of these strains.

4. In culture, these eight different isolations may be divided into three distinct strains as shown by differences in their rate of growth, type of colony, time of sclerotia formation, and in the number, size and color of sclerotia.

5. Strains I to VI, which are isolated from either tomato, peanut, bean or pineapple showed only slightly differences and are considered identical or the same. These strains appear to be the most common strain found from most agricultural regions of Luzon.

6. Strain VII differed from the above strains in being slow grower, with thicker or coarser mycelia and produced few, big, ovoid to very irregular shape sclerotia. At 33–35°C., this strain failed to produce sclerotia while Strains I to VI produced their sclerotia abundantly.

7. Strain VIII is also a slow grower like Strain VII, but it differs from Strain VII or from Strains I to VI not only on the type of colony produced, but also in its failure to produce sclerotia on any culture media or at any temperature to which it is subjected. The color of sclerotia or size of sclerotia when produced also differed from the rest of the strains. This strain appeard to be limited in its distribution.

8. No marked difference was noted in regards to their temperature requirements for growth, for sclerotia formation or for germination of sclerotia. Growth was obtained between 10°C. to 35°C. with optimum between 28–30°C, maximum slightly below 42° and the minimum at about 10°C. At 6–8°C., all the strains were checked in growth and remained dormant and at 42–45°C. were also checked in growth but were killed after 3 to 5 days exposure.

9. The sclerotia of various strains germinated readily on nutrient solution, on lower concentration of citric and tartaric acids, and on 1 to 5 per cent glucose. Fairly good germination were also obtained with 1 to 2 per cent sodium chloride and on tap and sterile water.

10. The viability of the sclerotia of the common strain of *S. rolfsii* was studied, and found to germinate readily on surface of moist soil, and even if it fails to germinate under this condition

for more than 10 days they were still found viable when plated on potato agar.

11. Burying the sclerotia even as deep as 4 inches in moist soil or buried 2 inches in flooded soil from 40 to 60 days did not materially affect their viability as these sclerotia, when recovered and plated, showed high percentage of viable sclerotia. Those buried 5 to 6 inches deep were greatly affected, and after 45 to 60 days nearly all the sclerotia were dead.

12. The sclerotia or mycelia are only very active when they are near the surface of moist soil. Infection was obtained on susceptible plants when the mycelia or sclerotia of the fungus are on the surface or buried 1 inch deep. Delayed infection was noted with the fungus buried 2 inches deep, and no infection was obtained where the fungus was buried at 3, 4, 5, and 6 inches deep.

13. The sclerotia could resist longer drying period in the laboratory than the mycelia. Under our tests, the mycelia were dead after 8 months, while the sclerotia were not all dead after 12 months.

14. The sclerotia are more tolerant to heat than the mycelia. The mycelia were killed at 48–50°C. and at 50 to 52°C. after 3 minutes exposure, and at 58–60°C. and at 60–62°C. after 1 minute exposure. The sclerotia withstood all the first three temperature ranges with longer exposure, but at 60°–62°C. the sclerotia were also killed after 1 minute exposure.

15. Certain commercial varieties of tomatoes were tested and found all susceptible to the common strain of *S. rolfsii*. The relative susceptibility, however, varied with the strains.

16. Suggestions for control of the disease is briefly discussed.

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ILLUSTRATIONS

Plate 1

Figs. 1. and 2. Mature tomato plants showing injury on the stem caused by *S. rolfsii*. The thick, white mycelia of the fungus may be seen.

3. An enlarged photograph of Fig. 2, showing more distinctly the type of injury. The thick, white mycelia of the causal fungus is seen extending up the stem.

4. Tomato fruit naturally infected in the field in Trinidad Valley, Mountain Province. The basal end of the fruit is rotted and the young sclerotia of the fungus may be seen.

5. Rotted tomato stem showing the development of sclerotia inside the stem. The stem is opened to show the sclerotia in the pith cavity.

Plate 2

Fig. 1. Infected tomato stem put in moist petri dish for 48 hours at 28–32°C. Thick white strands of mycelia are developed from which a pure culture of *S. rolfsii* may be obtained.

2. A common table beet naturally infected in the field by *S. rolfsii*. The basal end was completely rotted resulting in the death of the plant.

Plate 3

Fig. 1. Young tomato plants planted in soil put in celluloid cylinders where the fungus was buried 1 inch deep. Four plants died after 4 days and the other died later.

2. Tomato plants planted where the fungus was burried 2 inches deep. No infection resulted after 4 days, but later on, two plants became infected when mycelia of the fungus spread toward the surface.

3. 4, 5, and 6. Young tomato plants planted on the same day as those shown in Figs. 1 and 2, but the fungus was buried 3, 4, 5, and 6 inches deep. No infection resulted and the plants remained healthy until the end of the experiment.

7. Peanut plants artificially inoculated by placing bits of mycelia from a young colony of *S. rolfsii* near the stem. Three of the plants became infected; after 10 days they began wilting.

8. Peanut plants which served as check and was not inoculated.

9. and 10. Two of the peanut plants shown in Fig. 7 showing the injury on the stem.

Plate 4

Comparison on the type of colony produced by various strains on different culture media (3 days old colony).

Fig. 1. (Left to right), shows strains II, III, IV on potato agar.

FIG. 2. (Left to right) shows Strains VI, VII, VIII on potato agar.
3. (Left to right) shows Strains IV, VII, VIII on malt agar.
4. (Left to right shows Strains II, III, and IV on oatmeal agar.
5. (Left to right) shows Strains VI, VII and VIII on oatmeal agar.

The type of colonies produced by the various strains showed slight differences when the colonies are young.

PLATE 5

Comparison on the type of colony produced by Strains II, VII, and VIII on different culture media (12 days old).

FIG. 1. Strains II, VII, and VIII on potato agar.
2. Strains II, VII, and VIII on malt agar.
3. Strains II, VII, and VIII on oatmeal agar.
4. Strains II, VII, and VIII on peanut agar.
5. Strains II, VII, and VIII on corn meal agar.

Differences on the type of colony produced by Strain II, as is true with Strains I, III, IV, V, and VII differed markedly from Strain VII or Strain VIII. Strain II produced abundant sclerotia, Strain VII, few and limited, while Strain VIII produced fine, fluffy to stringy mycelia ,but failed to produce sclerotia. Only sclerotia "initials" were produced by this strain which never matured even after 30 days on potato agar.

PLATE 6

Comparison on the type of colony produced by various strains on diffrent culture media (22 days old).

FIG. 1. Strains II, III, and IV on potato agar.
2. Strains V, VII, and VIII on potato agar.
3. Strains II, III, and IV on peanut agar.
4. Strains V, VII, and VIII on peanut agar.
5. Strains VI, VII, and VIII on oatmeal agar.

Differences are noted in the type of colony and in the number of sclerotia produced by each strain. Strains VII produced few, but larger sclerotia than Strains I to VI. Strain VIII failed to produce sclerotia, but its sclerotia initials are very evident on potato agar, and oatmeal agar.

PLATE 7

Comparison on the type of colony produced by strains I to VI on steamed cornmeal, cornmeal agar and steamed oatmeal.

FIG. 1. Strains I, II, and III on steamed cornmeal.
2. Strains I, II, and III on cornmeal agar.
3. Strains IV, V, and VI, on steamed cornmeal.
4. Strains I, II, and III on steamed oatmeal.
5. Strains IV, V, and VI on steamed oatmeal.

Strains I, II, IV, and V on steamed cornmeal produced earlier and very abundant sclerotia than Strain III or Strain VI. The sclerotia produced on this media is more numerous than the same

strain on cornmeal agar. On steamed oatmeal less abundant sclerotia was produced by Strains I to V, and Strain VI delayed and very few sclerotia produced in comparison with the other strains.

PLATE 8

Comparison on the type of colony produced by various strains on different culture media (12 days old).

FIG. 1. Strains III, VII, and VIII on steamed corn meal (12 days).
2. Strains III, VII, and VIII on corn meal agar (12 days).
3. Strains VI, VII, and VIII on steamed oatmeal (12 days).
4. Strains VI, VII, and VIII on oatmeal agar (12 days).
5. Strains IV, VII and VIII on steamed oatmeal (4 days).

Marked differences are noted on the 12 days old colonies of Strains VII and VIII from the other strains, Figs. 1, 2, 3, and 5. On Fig. 5 slight differencees are noted on the 4 days old colony of Strains IV, VII, and VIII.

PLATE 9

Comparative sizes of sclerotia of various strains.

FIG. 1. (Left to right) plate culture of Strains VI and VII on steamed oatmeal agar (25 days old).
2. (Left to right) sclerotia produced by Strains VI and VII on potato agar (about 2.4 times).
3. (Left to right) sclerotia of Strains I, II, and IV on potato agar (about 2.4 times).

PLATE 10

Comparison on type of colony produced by various strains at 13–15°C., 28–30°C. and 33–35°C. (4 days old)

FIG. 1. Strain I at 13–15° C., 28–30°C. and 33–35°C.
2. Strain IV at 13–15°C., 28–30°C., and 33–35°C.
3. Strain VI at 13–15°C., 28–30°C., and 33–35°C.
4. Strain VII at 13–15°C., 28–30°C., and 33–35°C.
5. Strain VIII at 13–15°C., 28–30°C., and 33–35°C.

PLATE 11

Comparison on the type of growth produced by Strains I, II, III, and IV at 13–15° C., 28–30°C. and 33–35°C. (14 days old).

FIG. 1. Strain I at 13–15°C., 28–30°C., and 33–35°C.
2. Strain II at 13–15°C., 28–30°C., and 33–35°C.
3. Strain III at 13–15°C., 28–30°C., and 33–35°C.
4. Strain IV at 13–15°C., 28–30°C., and 33–35°C.

Differences are noted in the type of colony produced at different temperatures, but no marked differences could be noted between the strains when incubated at the same temperature. Early formation of sclerotia were noted at the two higher temperatures, but at the lowest temperature, sclerotia formation was delayed or even failure of some cultures to produce sclerotia.

PLATE 12

Comparison on the type of colony produced by Strains V, VI, VII, and VIII at 13–15°C., 28–30°C., and 33–35°C. (14 days old).

FIG. 1. Strain V at 13–15°C., 28–30°C., and 33–35°C.
2. Strain VI at 13–15°C., 28–30°C., and 33–35°C.
3. Strain VII at 13–15°C., 28–30°C., and 33–35°C.
4. Strain VIII at 13–15°C., 28–30°C., and 33–35°C.

Strains V and VII are similar in growth as those of Strains I, II, III, and IV as shown in Plate 11. Strain VII and Strain VIII differed from the above strains in the type of colony and production of sclerotia. Strain VII produced its sclerotia at 13–15°C., and at 28–30°C., but failed to produce at 33–35°C. Strain VIII failed to produce sclerotia at any of these temperatures.

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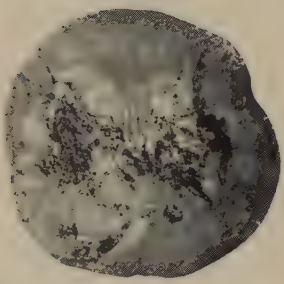

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PLATE 1.

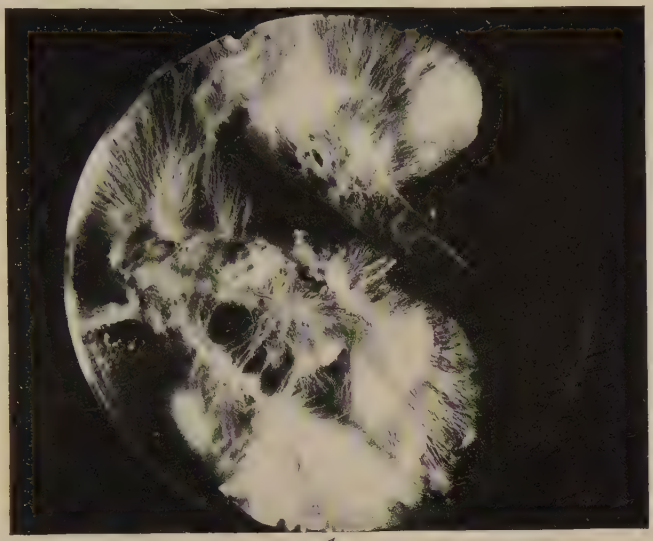

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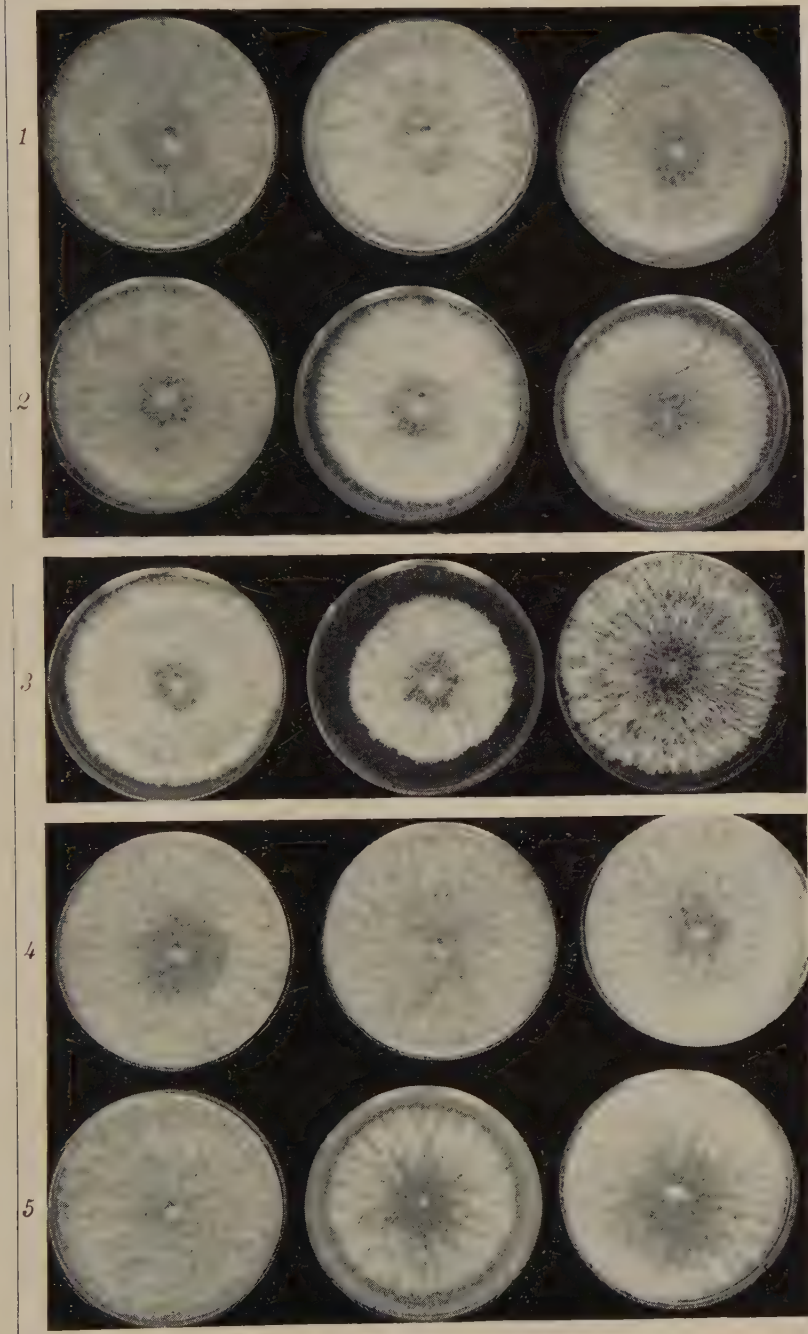
PLATE 2.

PLATE 3.



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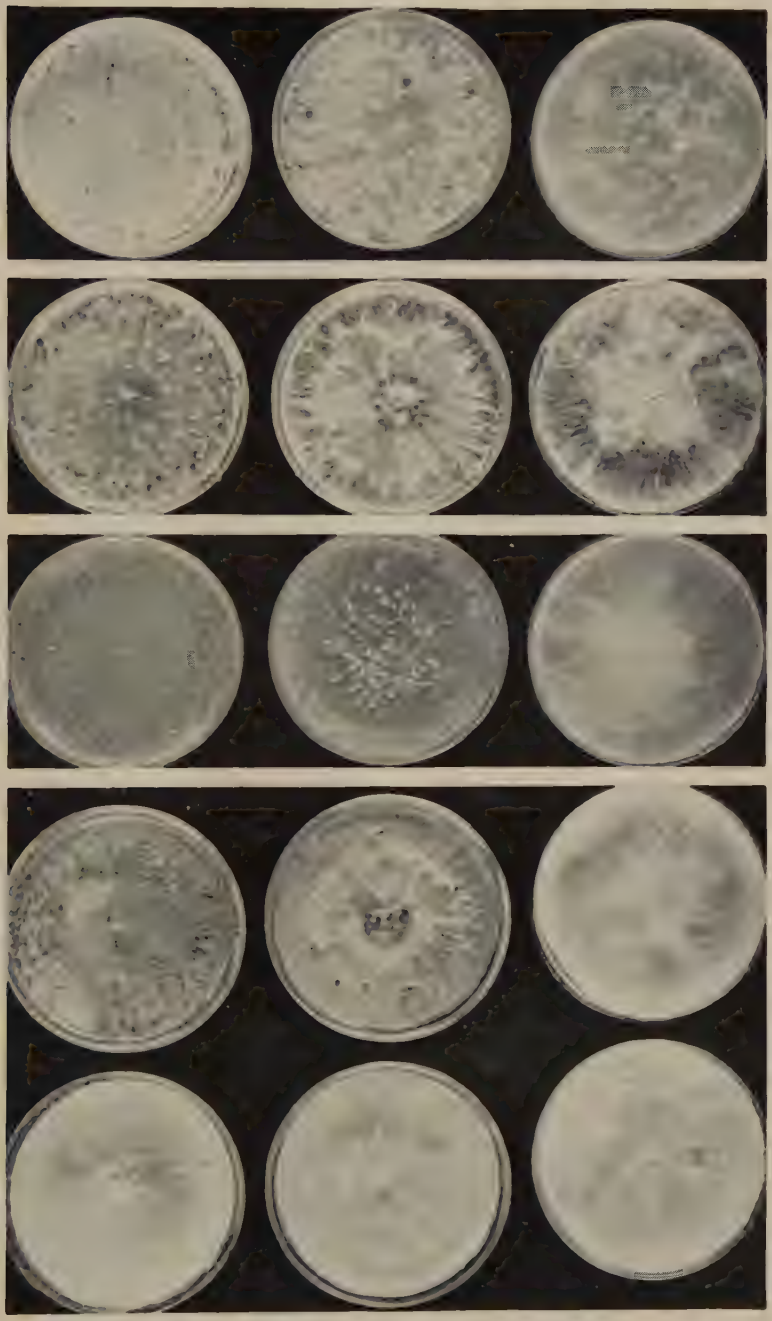

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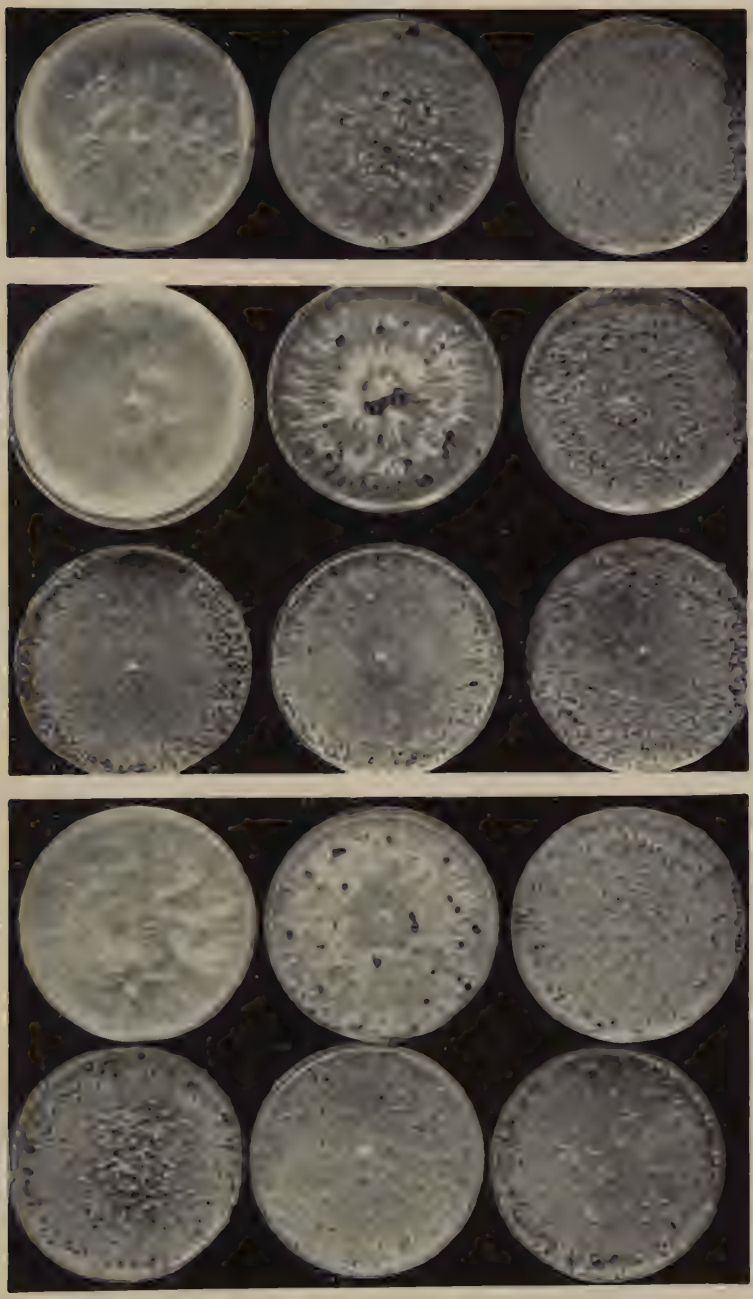

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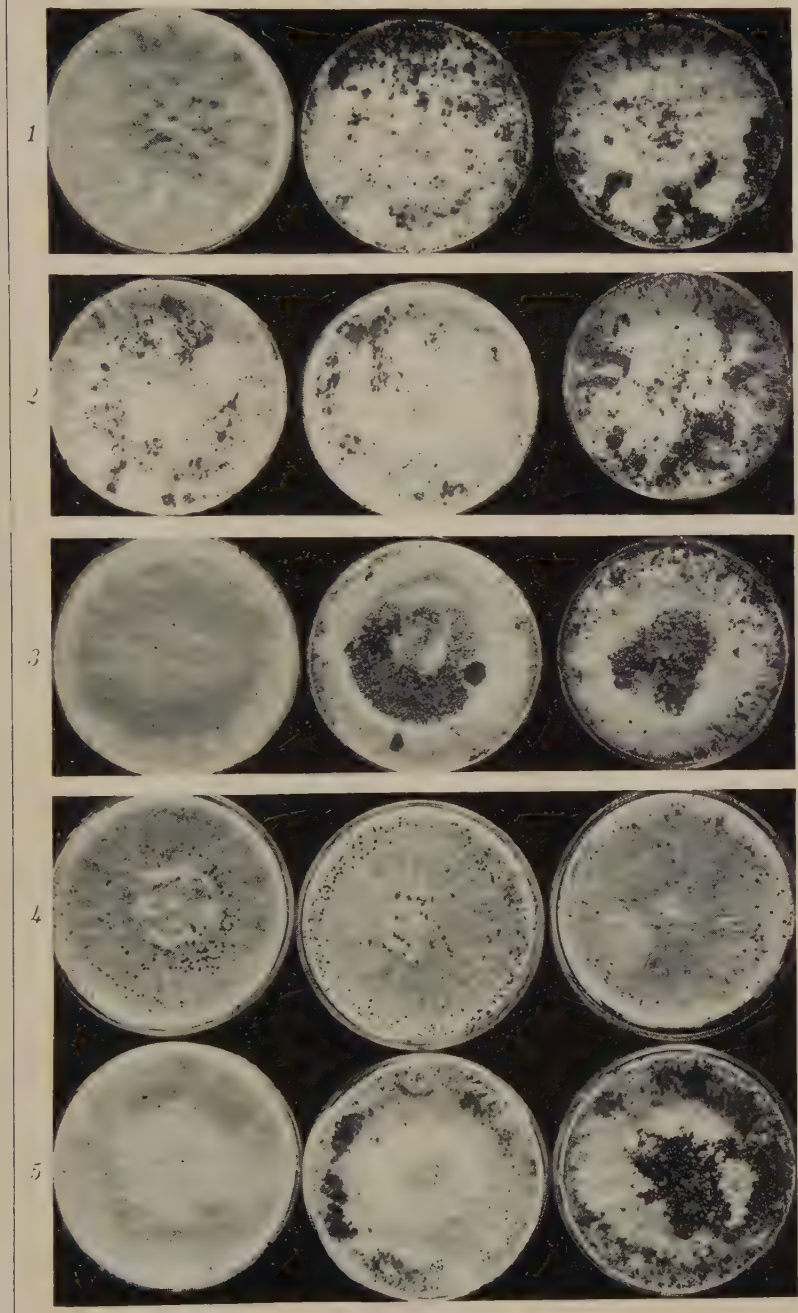

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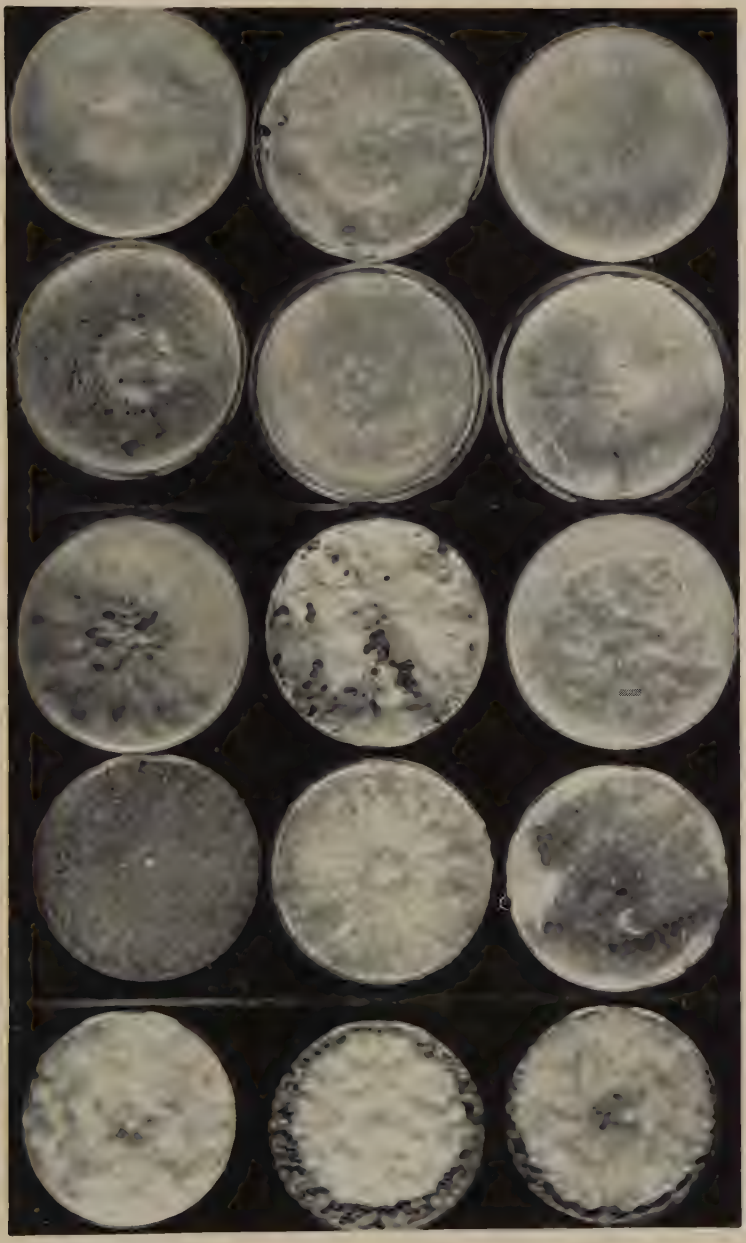

PLATE 8.

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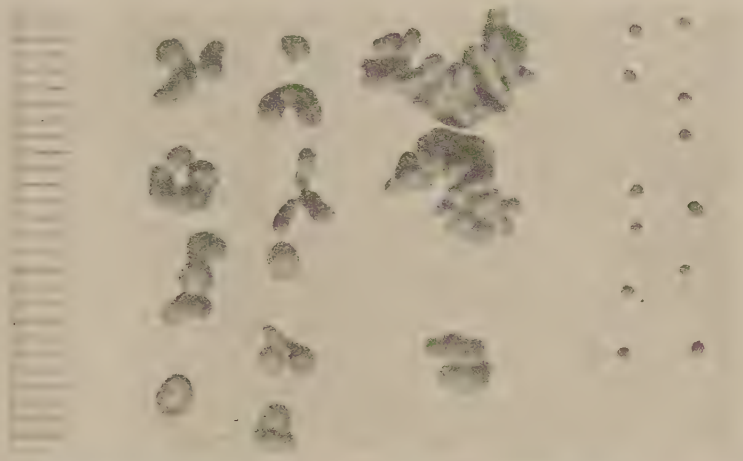

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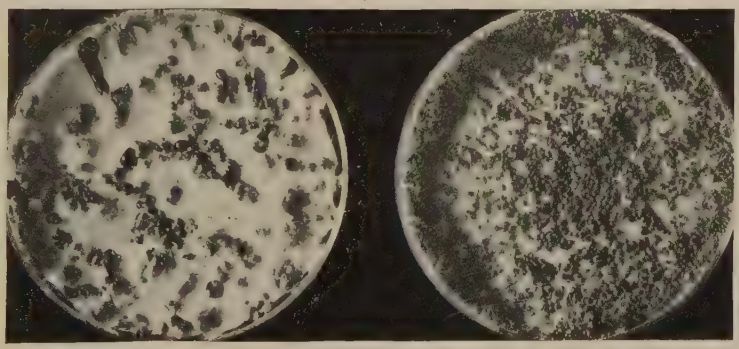

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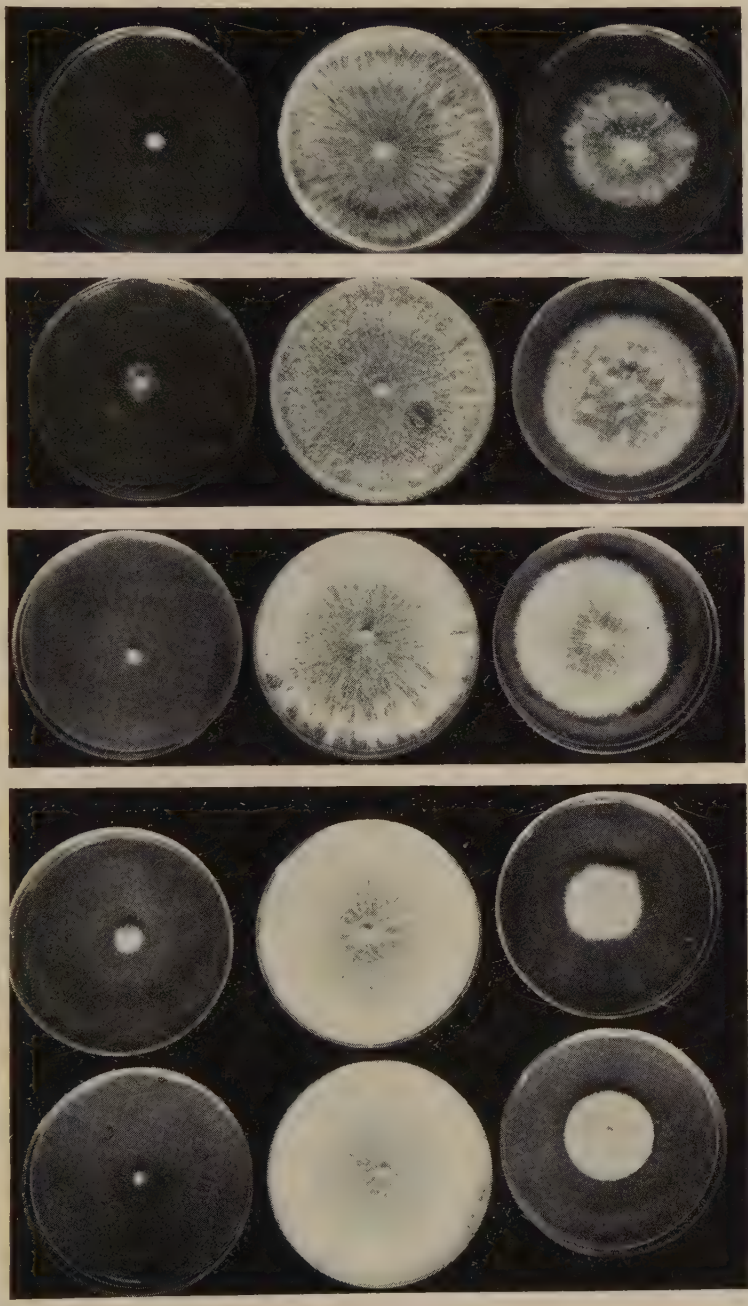

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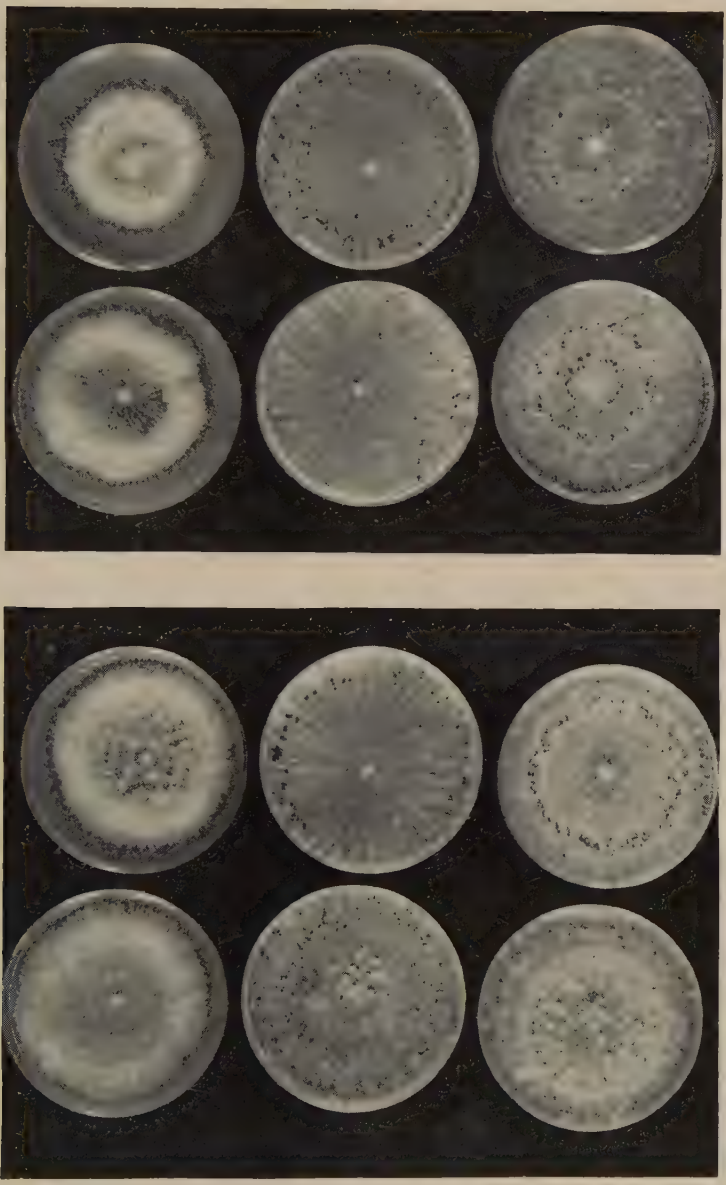

PLATE 11.

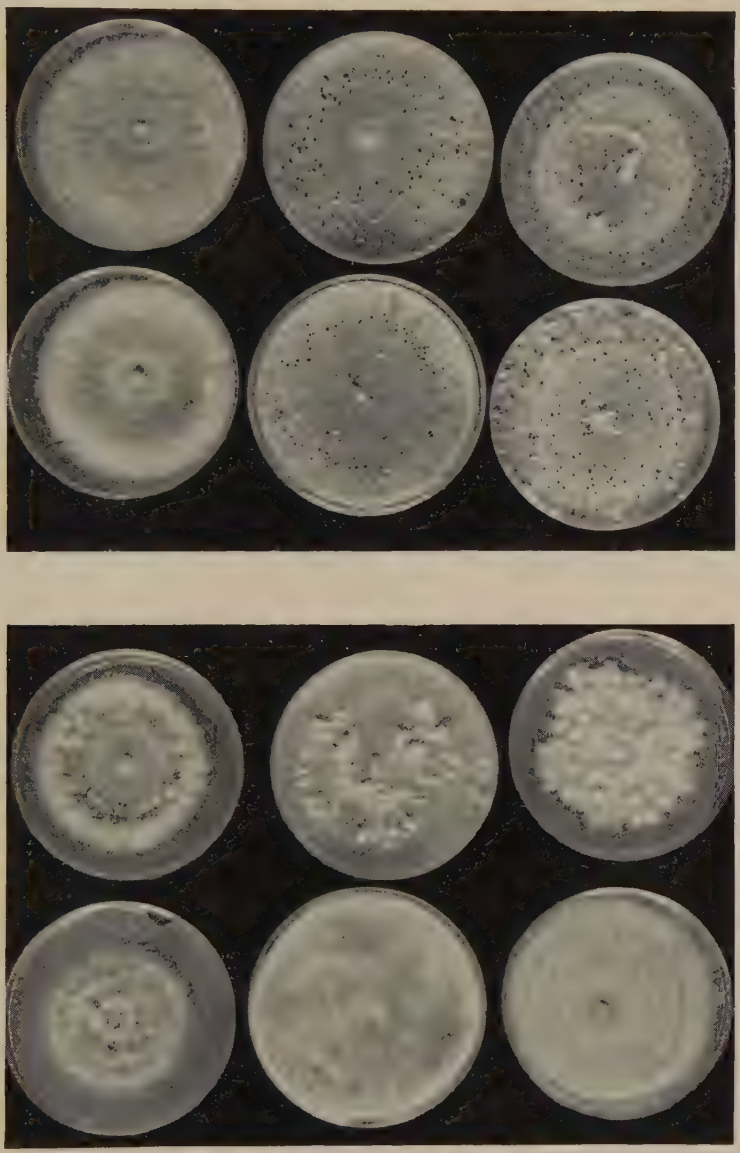

PLATE 12.

FURTHER STUDIES ON THE CONTROL OF LEAFHOPPERS AND TIP-BORERS ON MANGO INFLORESCENCE

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Bureau of Plant Industry

SEVEN PLATES

INTRODUCTION

The increasing demand for mango as a dessert and its great possibilities as a profitable export product have directed the attention of mango growers to its production on larger scale. Consequently, one may now see vast mango plantations in Muntinlupa and Novaliches, Rizal, and in some parts of Pangasinan, Batangas, Pampanga, Nueva Ecija, Bulacan, and Cavite. In so raising large-scale plantations, however, the growers have unknowingly opened up convenient fields for the activities of insects and fungi inimical to mango and have encouraged mass attacks from pests to which mango is host. The result is that there are now, not only more numerous species of insects, but also more dangerous ones to fight against than there ever had been. The depredations, particularly of the most insidious mango pests commonly known as leafhoppers and tip-borers, have cause incalculable damage during the last five or six years. In view of the rapidity with which these insects multiply, spread and cause damage to mango blossoms and the apparent helplessness of the growers to stem their ravages, the situation seems to indicate that the objective of increasing mango production cannot be attained by merely planting more trees or extending the area of cultivation and by following all the necessary cultural practices. Rather, it is attained by saving the crop from the depredations of leafhoppers, tip-borer and other serious pests and diseases, barring the effects of unfavorable climate.

In the past few years both the Bureau of Science and the Bureau of Plant Industry received numerous complaints about the menace of the leafhopper and the tip-borer. These complaints, together with inquiries from various mango-growing districts as

to how to control them, show the extent and seriousness of the destructions of these pests. Accordingly, investigations and experiments to develop sprays and spray schedule to check the ravages of these pests were conducted. Some of the sprays developed were so expensive and impractical that they could not in any way make for the yield any commercial profit. Recently, Serrano and Palo(21) reported that the leafhoppers on mango inflorescence can be controlled with common Chinese laundry soap, which is relatively cheap, and readily available locally, by spraying the infested flowers of Carabao and Pico trees, respectively, with 0.5 per cent and 0.4 per cent solutions. Since their work on soap spraying for leafhoppers was only preliminary and had covered but one season of experiments and observation, the necessity for additional experimental work on the same matter is obvious in order to ascertain whether it should be recommended on commercial scale.

Therefore, the purpose of this paper is to throw more light upon our present knowledge of the control of tip-borer and leaf hoppers on mango inflorescence in the Philippines. The results of the present studies on the control of these pests are embodied in a single paper. The main part of these studies was done in Novaliches Mango Plantation and Muntinlupa Plantation, Rizal, from October, 1933, to June, 1935. Supplementary field observations were made in Pasay, Rizal and in Bulacan since 1931.

THE TIP-BORER AND ITS CONTROL

HISTORY AND DISTRIBUTION

Chlumetia transversa formerly known as *Nachaba transversa* Wlk., *Chlumetia guttiventris* Wlk., and *Ariola corticea* Snell. was first described by Walker(25) in 1863. According to Fletcher(4) this insect is generally considered a minor pest of mango in many parts of India. The collection of *Chlumetia transversa* in the British Museum(5) showed that it is also present in Ceylon, Malay Peninsula and in some islands in the East Indies.

The earliest description of considerable harm done by this pest to the young, tender terminal growths of mango in the Philippines was published by Wester(28) in 1920. The pest is widespread in the Philippines and has been reported alarming in many places. An attempt to control this pest in this country was reported by Palo(17) in 1932 in which he obtained a doubtful but encouraging result with the use of lead arsenate in com-

bination with either Bordeaux mixture or lime-sulphur as preliminary spray.

NATURE OF THE INJURY AND ECONOMIC IMPORTANCE

The tip-borer pest, the larva of a moth (*Chlumetia transversa* Walker), is one of the most common insect pests of mango in the Philippines. The insect attacks the mango by boring into the panicles (Plate 1, fig. 1) or young shoots (Plate 1, fig. 2) at or about their tips and then tunneling its way down to the basal part, thereby, causing the tops to shrivel and dry. In all of the mango-growing regions of Luzon this insect has already been known as a dangerous pest and is considered one of the factors responsible for the diminished yearly output of the crop. Palo(17) reported this pest as causing damage from 0.5 to 25.0 per cent of the mango inflorescences in Quingua, Bulacan, in December, 1930, and found it to be equally severe in Muntinlupa, Rizal, in 1931.

Observations on the incidence of this pest in various places during the last four years show that the severity of damage done by this insect to the mango depends upon the age of the infested infloresence and the numerical abundance of the insect. Young panicles bored into by the insect seldom escape death but older inflorescences attacked by the same pest usually show unharmed lower laterals which may continue to develop the fruits. In one instance the present writers recorded 90 per cent tip-borer infestation on one tree, and in another 73.0 per cent with 44.0 per cent dead panicles in the Novaliches Mango Plantation. Since many of the infested inflorescences continue to develop the fruits, some growers believe that the pest is not so harmful as to warrant any serious attention as regards its control, without considering the fact that the injury somehow weakens the inflorescences and reduces their vitality. Owing to its widespread outbreak in the Philippines and the more or less serious injury that it causes to the mango flowers, the tip-borer pest is ranked with the factors of some economic significance in the mango industry and is, therefore, one of the problems to consider in solving mango failure.

SEASONAL ACTIVITIES

Periodic field observations on the destructiveness of the tip-borer pest were started in 1931 in Muntinlupa and Pasay, Rizal, and were continued up to 1935. Monthly observations (Table 1)

TABLE 1.—*Monthly observations on the prevalence of tip-borer (Chlumetia transversa) at Novaliches Mango Plantation*

Year	Month	Number of trees examined	Number of shoots or panicles examined per tree	Tip-borer infestation		Remarks
				Range	Average	
				Per cent	*Per cent*	
1933	October	18	120 panicles	2.0–90.0	28.4	On off-season flowers produced by smudging.
	November	20	200 panicles	5.0–80.0	31.7	Do.
	December	35	200 panicles	11.0–44.0	24.8	Do.
	January	46	200 shoots	11.5–28.0	17.7	On new leaf shoots.
	February	56	200 shoots	9.5–28.5	16.8	Do.
	March	20	200 shoots	0.0– 4.5	1.6	On normal season flowers.
	April		100 panicles		Negligible	Do.
	May		100 panicles		Nil	No leaf shoots, no flower.
	June	20	20 shoots	1.0–22.5	10.7	On new shoots produced by a few trees.
1934	July				Negligible	Do.
	August				Nil	No leaf shoots, no flower.
	September				Nil	Do.
	October				Nil	Do.
	November				Nil	The few flowers produced by smudging this month showed no infestation.
	December				Nil	Do.
	January	50	200 panicles		Negligible	First wave of flowering. Many trees produced flowers but practically no infestation was observed.
1935	February	50	200 panicles		Do	
	March	50	200 panicles		Do	
	April	50	200 panicles	5.0–12.0	7.0	Second wave of flowering.
	May	50	200 panicles	2.0– 6.0	5.0	Third wave of flowering. ('Flowers and leaf shoots').
	June	20	120 shoots	0– 3.0	1.2	On new leaf shoots.

on the prevalence of this pest in Novaliches Mango Plantation were also made from October, 1933, to June, 1935.

The tip-borer pest was found active only when the trees were in leaf or flower flush. Its destructiveness appears to be influenced to a certain extent by climatic conditions. It has been observed to be highly destructive to the shoots and flowers (off-season) produced during the months of October, November, December, and January. The flowers and shoots produced during the warm dry months (February, March, and April) are usually not seriously attacked. The infestation on the young shoots produced during the rainy months (July, August, and September) are occasionally serious. Storms and strong typhoons apparently affect adversely the tip-borer population as evidenced by the almost complete absence of the insect on flowers and young shoots produced during December, 1934, and January, February and March, 1935, following the terrific storms which lashed the central provinces of Luzon in mid-October and mid-November, 1934, and which blew down almost 90 per cent of the mango trees in Novaliches Mango Plantation.

Considering the length of tip-borer generation as extending from the time the eggs are deposited until the eggs from the progeny are laid, in Novaliches Mango Plantation, there may be as many as four or more generations. In cases where flowering continues from October to April or where the production of new leaf flushes overlaps, tip-borer infestation may always be observed and the generations correspondingly overlap one another.

The habits of this insect during the months when there are neither flowers nor leaf shoots are not known. It is believed that it can live also on plants other than mangoes but a search for such plants was unsuccessful. The absence of the insect during a prolonged period of 3 or 4 months when sometimes no shoot or flower is produced indicates that perhaps it aestivates in certain inconspicuous places or lives on some other hosts.

LIFE HISTORY AND DESCRIPTION OF CHLUMETIA TRANSVERSA

Methods of study.—The life history of *Chlumetia transversa* was studied from January to May, 1934, in the Novaliches Mango Plantation, Novaliches, Rizal, owned by Dr. Nicanor Jacinto but temporarily being used by the Bureau of Plant Industry for experimental work. It was thought at first that this work could be started from the adults reared from cultures in battery jars but the moths obtained would not copulate when released

in insect cages containing young mango inflorescences and tender shoots to which either water or dilute solution of honey or sugar was sprayed as feed.

Several mango leaf buds in a number of trees were then tagged and were examined daily, morning and afternoon, with the aid of a magnifier for the presence of eggs. The shoots on which eggs were deposited were collected and brought to the laboratory in the plantation house. Each shoot, with leaves removed, was placed in a test tube (1.6 cm. diameter by 15 cm. long) containing a layer of soil, about 3 centimeters thick, at the bottom. The test tube was plugged with loose cotton and then labelled. Daily observations, morning and afternoon, on hatching of the eggs were made. The larva obtained was reared in the same test tube by giving it a fresh, young, tender shoot or flower stem which it bored later. The life history work ended with the emergence of the moths from their pupal stage.

Egg.—The eggs (Plate 2, fig. 1), which are laid singly on the young panicle or shoot, are frequently found imbedded in droplets of milky fluid which is perhaps an excretion of the female. They are creamy white, ellipsoidal, about 1.2 millimeters long and 0.74 millimeter thick. When the eggs are about to hatch they turn light brownish. They hatch in from 3 to 7 days or an average of 4.1 days (Table 2).

TABLE 2.—*Life history of tip-borer (Chlumetia transversa)*

Culture number	Incubation period	Larval stage	Pupal stage	Life history from egg to adult
	Days	*Days*	*Days*	*Days*
1	5	7	12	24
2	5	12	13	30
3	5	7	16	28
4	7	7	12	26
5	7	10	13	30
6	3	10	13	26
7	3	10	14	27
8	4	8	12	24
9	3	10	13	26
10	4	9	15	28
11	3	8	8	19
12	3	8	9	20
13	4	8	15	27
14	4	9	15	28
15	4	11	15	30
16	3	12	17	32
17	3	9	15	27
Average	4.11	9.11	13.35	26.58

Larva.—The newly-hatched larva (Plate 2, fig. 2) is light brownish, about 1.5 millimeters long and 0.8 millimeter thick. It is cylindrical and tapering at both ends with one short hair set laterally on each abdominal segment. The head is oval, dark brown with a distinct frontal suture. The thorax is about 0.12 millimeter long. The prothorax is chitinized at pronotum and is almost as long as either the mesothorax or metathorax. The abdomen is about one millimeter long and consists of 9 segments which are all of practically the same length except the one adjacent to the caudal plate.

The full grown larva (Plate 2, fig. 3) is about 10.2 millimeters long and 2.5 millimeters thick and is light purple at dorsal surface and pale yellow at ventral side. With the exception of its bigger size, it looks similar to the newly hatched larva. The different larval instars could not be determined because the exuviæ could not be found in the tunnel and among the excreta of the larva. It is believed that the larva eats up its exuvia. The larval life covers a period of from 8 to 12 days or an average of 9.1 days (Table 2).

Pupa.—Before pupation the larva crawls upon the branch and trunk down to the base of the tree. The insect pupates in the soil near the base of the tree. The present junior author at one time picked several of these pupæ from the soil near the base of a mango tree and after rearing them in the laboratory for a few days the adults that emerged were in all cases *Chlumetia transversa.*

The pupa (Plate 2, fig. 4) is light brown, about 8.4 millimeters long and 2.5 millimeters in diameter at its thickest part. The head is oval with genæ broadly expanded and frons reduced. The antennæ are filiform, about 5 millimeters long. The thorax is about 3.2 millimeters long. The prothorax is coarsely punctate with a ridge at the middle and is about one-third as long as the thorax. The wing pads occupy the first four abdominal segments and are about one-half as long as the body. Under laboratory conditions the pupal stage covers a period of from 8 to 17 days or an average of 13.35 days (Table 2).

Adults.—The male (Plate 2, fig. 5) is grayish-black with a wing spread of about 16 millimeters. The forewings are crossed by wavy black lines at basal, subbasal, medial, and discal parts and a row of linear black spots at the margin. The hindwings are pale brownish. The body is about 8 millimeters long. The head is grayish. The antennæ, which are each about 5 milli-

meters long, are filiform with a hair-like projection at each segment. The thorax is about 2.5 millimeters long. The abdomen is about 4.5 millimeters long with a small black crest on from the second to the fourth segment.

The female (Plate 2, fig. 6) is about 10 millimeters long, with a wing spread of about 18 millimeters. It is similar to the male in all body characters except that it does not have the black crest on the abdominal segments.

SPRAYING FOR TIP-BORER WITH LEAD ARSENATE

When to spray for tip-borer.—Since the damage is done by the insect while inside the panicle, it appears that control by spraying with stomach poison is of no use. In observations made by the present junior author in the Novaliches Mango Plantation it was found that the newly-hatched larvæ feed for some time outside the panicle upon soft, tender tissues before it starts to eat up its way into the flower-stem. This interval between hatching of the egg and the entrance of the caterpillar into the panicle offers the best opportunity to kill the pest by means of the stomach spray. The insect may also be killed by the spray when it comes out from the infested inflorescence to attack a fresh panicle. In subsequent spraying experiments aimed to control the tip-borer, the application of the poison was so adjusted as to cover the period of vulnerability in the larval life of the insect.

Materials and methods.—Three series of spraying experiments, in which 0.5 per cent lead arsenate (Orchard Brand) was used to control the tip-borer pest on off-season flowers, were conducted in Novaliches Mango Plantation. The first and second series were performed in November and the third, in December, 1933. The lead arsenate spray was applied at different regular intervals beginning when the panicles were usually about 2 to 6 centimeters long.

In the first series lead arsenate was applied only to half crowns of seven trees leaving their other halves unsprayed as checks. Three of the trees were sprayed 2 times at six days' interval and the remaining four trees, 3 times at 3 days' interval. In the second series sixteen trees were used, the first four were sprayed 3 times at 3 days' interval; the second four, 3 times at 4 days' interval; the third four, 2 times at 6 days' interval; the fourth four, were left unsprayed as checks. In the third series twenty-six trees were used, 13 were sprayed 3 times at 3 or 4 days' interval and the other 13 were used as checks. The results of

these spraying experiments are given in terms of per cent tip-borer infestation (Tables 3, 4 and 5) which were determined, when the inflorescences were full grown, by recording the number of attacked inflorescences in every 150 to 200 counted.

Discussion of results.—In the first series of spraying experiments (Table 3) it may be seen that there is a marked difference

TABLE 3.—*Results of spraying half crowns of carabao and pico trees for tip-borer with 0.5 per cent lead arsenate*

Treatment	Tree number	Variety	Tip-borer infestation based mainly on 150-200 panicles per tree		Panicles totally destroyed by tip-borer		Average tip-borer infestation		Average panicles totally destroyed by tip-borer	
			Sprayed	Check	Sprayed	Check	Sprayed	Check	Sprayed	Check
Two sprayings, 6 days' interval.	6	Pico	9.60	29.50	1.20	7.30	7.95	39.50	0.7	17.10
	10	Carabao	7.47	16.00	.00	.00				
	14	Do	6.80	73.00	0.93	44.00				
Three sprayings, 3 days' interval.	7	Pico	1.00	39.74	0	5.98	1.53	42.31	0	2.98
	11	Carabao	2.30	40.80	0	0				
	13	Do	1.81	47.70	0	5.70				
	16	Pico	1.01	41.00	0	0				

in tip-borer infestation between the sprayed and check halves. Assuming that the distribution of the insect is uniform in each of the trees used in this series, spraying with 0.5 per cent lead arsenate had, therefore, reduced tip-borer infestation on the average from 39.50 to 7.95 per cent on halves sprayed two times at six days' interval and from 42.31 to 1.53 per cent on halves sprayed three times at three days' interval. Correspondingly, the percentage of panicles totally destroyed by the tip-borer pest is higher on the check halves than on sprayed halves. The three-spray schedule at three days' interval gave a more satisfactory control than the two-spray program at 6 days' interval.

In the second series of experiments (Table 4) a much reduced tip-borer infestation was shown by lead arsenate-sprayed trees. No significant difference is, however, noted between the results given by the three-spray schedule at 3 days' interval and the three-spray schedule at 4 days' interval, the slight difference being in favor of the first program. As in the first series, the results obtained from two-spray program in this series were not as satisfactory as those obtained from any of the other two spray schedules. In all cases, however, lead arsenate sprayings

TABLE 4.—*Results of spraying carabao trees for tip-borer with 0.5 per cent lead arsenate at different intervals*

Treatment	Tree number	Tip-borer infestation based on 150-200 panicles per tree	Panicles totally destroyed by tip-borer	Average	
				Tip-borer infestation	Panicles totally destroyed by tip-borer
		Per cent	*Per cent*	*Per cent*	*Per cent*
Three sprayings, 3 days' interval	5	1.01	0	2.00	0.27
	17	2.00	0.27		
	24	3.20	0		
	29	1.80	0.81		
Three sprayings, 4 days' interval	2	1.60	0	2.70	0
	9	2.27	0		
	26	2.30	0		
	27	3.26	0		
Two sprayings, 6 days' interval	4	5.43	0.58	5.43	0.57
	12	6.30	0.97		
	19	4.10	0.76		
	30	5.90	0		
Check	18	19.10	4.04	30.66	6.07
	21	42.17	7.40		
	23	23.80	2.27		
	31	37.60	10.60		

have shown some beneficial effects in reducing the volume of tip-borer infestation.

Since it has been clearly demonstrated in the first and second series that the three-spray schedule at 3 or 4 days' interval gave better results than the two-spray schedule at 6 days' interval, it was, therefore, logical to follow either one of the first two schedules in succeeding experiments. In the third series it was intended to follow the three-spray schedule at 3 days' interval but owing to interruptions caused by rains, the regularity of days of application could not be maintained faithfully; hence, the schedule was made either 3-day followed by the 4-day or a 4-day followed by 3-day interval. In this series tip-borer infestation was reduced from 25.92 to 4.76 per cent (Table 5).

From the foregoing studies it is shown that the best time to spray for tip-borer coincides with the period when the flowers, being still closed, show some resistance to the toxic action of the lead arsenate. Mango flowers, when open, had been observed to be sensitive to the toxic action of lead-arsenate spray. The first application of lead arsenate spray in the three-spray schedule was intended for the early brood larvæ while the third for the late brood larvæ. In the two-spray schedule the first ap-

TABLE 5.—*Results of spraying tip-borer with 0.5 per cent lead arsenate 3 times at 3–4 days' interval*

Treatment	Tree number	Variety	Tip-borer infestation based on 150-200 panicles per tree	Panicles totally destroyed by tip-borer	Average	
					Tip-borer infestation	Panicles totally destroyed by tip-borer
			Per cent	*Per cent*	*Per cent*	*Per cent*
Sprayed	3	Carabao	8.0	0	4.76	0.26
	6	do	9.5	0		
	11	do	1.0	0		
	12	do	3.5	0		
	17	do	5.5	3.0		
	18	do	6.5	0		
	19	do	5.0	0		
	23	do	4.5	0		
	24	do	2.0	0		
	30	do	5.0	0		
	34	do	2.0	0		
	35	Pico	1.0	0		
	40	do	8.5	0.5		
Check	4	Carabao	23.0	3.0	25.92	1.23
	5	do	33.0	0		
	7	do	29.0	0		
	8	do	16.0	0		
	13	do	26.0	3.0		
	14	do	27.0	2.0		
	15	do	37.0	4.0		
	27	do	20.0	2.0		
	29	do	20.0	0		
	39	do	15.0	0		
	41	Pico	19.0	0		
	42	Carabao	44.0	2.0		
	43	do	28.0	3.0		

plication was aimed at the early brood larvæ and the second at the late brood larvæ.

As a measure of tip-borer control, spraying the mango inflorescences with 0.5 per cent lead arsenate for three times at intervals of 3 or 4 days is beneficial. In commercial mango orchards where leafhopper infestation is very severe, it appears, however, that this treatment will be of no practical value in increasing the crop unless a satisfactory remedial measure against the leafhoppers is found.

PRUNING INFESTED SHOOTS AND INFLORESCENCES

The clean-culture method followed in modern orchards of other countries for the elimination of pests and diseases should be adopted in mango plantations in the Philippines. With reference to the control of tip-borer, this should include detection, collec-

tion and destruction of infested flowers and shoots. In this particular case the coöperation of all the growers in the community is necessary since it is impossible to stamp out the pest if all of the possible sources of infestation in a locality are not eliminated. Detection for the presence of this pest should be done only when the trees are either in leaf or flower flush. The infested terminal growth should be cut out with a tree pruner as soon as detected and then the larva, destroyed. Pruning of infested inflorescences should be done only when the trees show light infestation. If there is an indication that the infestation will be severe, lead arsenate spraying may be resorted to in order to reduce the harm that will be done by the pest. The inflorescences that will show the tip-borer after spraying should also be pruned and the larva inside, killed.

The value of clean-culture in connection with the control of tip-borer, twig-borer and various other insect pests and diseases should not be underestimated. Their elimination by this method may not be rapid but it is one of the best ways of helping to prevent their rapid multiplication and spread. This method should include also the prompt elimination of unnecessary trees, bushes, and shrubs, grasses and weeds which may harbor the mango pests.

NATURAL ENEMIES

Since the tip-borer pest is inside the shoot or panicle during the greater part of its larval life, it appears that it is concealed from its natural enemies. This does not prove to be the case, for the larva of this pest was found parasitized by *Chelonus* sp.,[1] (Plate 2, fig. 7) a grayish-black hymenopterous insect. Evidence pointing out to this parasitism was shown when several adults of the parasite were found in the cheese-cloth-covered culture jar, a few days after several infested young mango shoots containing the larvae of the tip-borer pest had been placed in the jar. The effectiveness of this parasite had not, however, been investigated.

CONTROL OF LEAFHOPPERS

PREVIOUS WORKS ON THE CONTROL OF MANGO LEAFHOPPERS

In India.—The leafhopper pests on mango inflorescence first attracted great interest in India where three species were recognized and identified in 1889 by Lethierry(13) as *Idiocerus ni-*

[1] Determined by Mr. F. Q. Otanes, Assistant Chief of the Plant Pest and Disease Control Division, Bureau of Plant Industry, Manila.

veosparsus,[2] *Idiocerus clypealis* and *Idiocerus atkinsoni*. One of the earliest attempts to control these insects was made in 1888(?) by Gollan of the Botanical Gardens at Saharanpur, who, according to Distant(3) used mixtures of soap, tobacco, sulphur, kerosene diluted with milk, etc., upon the pests but without beneficial results. Hartless(6) states that the most troublesome pest in Northern India is a species of *Idiocerus* for which control he suggested spraying with crude oil emulsion during its nymphal stages. Ballard(1) claimed to have obtained successful results in his spraying experiments at Varagambady, Madras Presidency in which he used crude oil emulsion and fish-oil soap against *I. niveosparsus*. The remedial measures prescribed by Madan Mohan Lal(14) for hoppers in Northern India are increasing the vitality of trees by thinning out groves and breaking up of soil surface around the roots, and five sprayings of fish-oil resin soap (1 lb. of fish-oil resin soap to 15 gallons of water) from February to March. A pre-blossom spraying of fish-oil resin soap was found by Subramania(22) to be fairly effective against the three species found in South India. Resin with a strong contact poison such as solignum or crude oil emulsion was claimed by Husain and Pruthi(7) to be the most effective winter spray for hoppers in Punjab. Spraying with resin wash was also reported by Bhasin(2) to have given good results. Finding no simpler remedy than spraying against the hoppers, Kannan(9) suggested that sacrificing the crop when blossoming is poor may prevent the insects from being carried over from one year to the next. Later on, the same author(10) reported that dusting infested trees with pyrethrum two or three times at intervals of a week is effective in killing the hoppers. Husain(8) tested various insecticides against *I. atkinsoni* and *I. clypealis* and found that only calcium cyanide dusts gave good results. Ramachandra Rao(19) found that a preliminary spray with Bordeaux mixture followed by fish-oil-resin soap and then by lead arsenate was effective in reducing the damage done by mildews, hoppers and caterpillars to the mango flowers. Kannan(11) and Subramaniam(23) reported that an extract of a plant, *Mundulia suberosa*, the active principle of which is rotenone, is effective against the mango hoppers. The latter author claimed that 0.5 per cent extract of the plant gave 100 per cent control of the nymphs after 24 hours.

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[2] This insect more appropriately belongs to the genus *Chunra* rather than to *Idiocerus*, according to Dr. G. Merino, Chief of Plant Pest and Disease Control Division, Bureau of Plant Industry, Manila.

In Dutch East Indies and Formosa.—Leefmans(12), Perriere(18) and Van Hall(24) reported the presence of *I. niveosparsus* on mangoes in Dutch East Indies and Schumacker(20) mentioned the prevalence of both *I. niveosparsus* and *I. clypealis* on mangoes in Formosa in his studies of the Homopterous Fauna of this island but no available literature on the control of these insects was found for these two regions.

In the Philippines.—The records of the Philippine National Museum showed that *I. clypealis* and *I. niveosparsus* were collected and identified as such by C. S. Banks in 1905 and 1909, respectively, but nothing was mentioned about the importance of these pests. The earliest description of serious leafhopper damage to mangoes in the Philippines was given by Wester(26) in 1911 for which control he(27) suggested later to follow the one recommended by Ballard(1) at Madras. Otanes(16) tried the common laundry soap and pyrethrum powder and found them to be deadly to the mango hoppers. Merino(15) reported that light-trapping and dusting with pyrethrum were found very effective in controlling mango hoppers and caterpillars. Nicotine soap was also reported by him to be deadly to the nymphs of the hoppers. Palo(17) in spraying experiments conducted in Muntinlupa, Rizal, to control mango hoppers, tip-borers and anthracnose found that a preliminary spray of either strong Bordeaux mixture-lead arsenate or lime sulphur-lead arsenate followed by nicotine soap, gave profitable results. In a more extensive spraying experiment in which soap or nicotine soap was used, Serrano and Palo(21) reported that successful results were obtained when either of the sprays was applied to the nymphs of the infested flowers 4 to 5 times at intervals of 3 days.

LEAFHOPPER POPULATION OF NOVALICHES MANGO PLANTATION BEFORE THE SPRAYING INVESTIGATIONS WERE STARTED

Before the spraying experiments were started in Novaliches Mango Plantation in October, 1933, a rough estimate of the abundance of the leafhoppers was made by counting in four different directions of the crown of a mango tree, without agitating the leaves, the number of hoppers found within an area of about a square meter. Of the 108 trees examined in different parts of the plantation, the present writers found that the leafhopper population per square meter of crown was on the average 2.49 *I. clypealis* and 0.048 *I. niveosparsus*. Computing from

these data, therefore, a tree with 70 square meters of crown [3] should have leafhopper population of 174.0 *I. clypealis* and 3.36 *I. niveosparsus*. Owing to the difficulty of observing for the leafhoppers, since many of them flew away when approached, these figures were considered lower than their actual number per tree. With these low figures, it would be a surprise to anyone why the few trees which produced flowers in the early part of the next month (November, 1933) were severely infested. The only explanations that could be offered are, firstly, that the flowers attracted most of the leafhoppers from neighboring trees, not to say the four-thousand trees in the whole plantation; secondly, that the climatic conditions during this period appeared to be favorable for reproduction and multiplication of these insects.

SOAPSUDS SPRAYING FOR THE CONTROL OF LEAFHOPPERS ON MANGO INFLORESCENCE

Materials and methods.—Seven series of soapsuds spraying for the control of leafhoppers on mango inflorescence were conducted in Rizal Province, six series in Novaliches Mango Plantation and one series in Muntinlupa Plantation. The soap used in the first six series was obtained from one of the factories in Manila and that used in the seventh series from a factory in Pasay. In all those series of experiments soapsuds of 0.5 per cent and 0.4 per cent concentrations were used, respectively, for the carabao and pico varieties except in the series performed in Muntinlupa Plantation in which 0.4 per cent solution was used for both varieties. In the first six series the soap solution was sprayed on the trees by drenching thoroughly the inflorescences with Deming hand pumps fitted with 15-meter rubber hoses and Bordeaux nozzles tied to 4- to 5-meter bamboo rods and in the seventh series it was applied with one-horse-power sprayer. Spraying the tops of trees was done with the aid of 4- to 6-meter bamboo ladders provided with props. The five-spray schedule at three days' interval originally planned was not carried out faithfully for all trees in each series as sometimes spraying was delayed one to three days because of continuous heavy rainfall, and at times spraying was done as frequently as six or seven times because of heavy reinfestation.

[3] The average tree in Novaliches Mango Plantation has a crown of more or less 70 square meters.

Before the spraying series was started a random examination of the leafhopper infestation was first made by counting the number of adult hoppers on every panicle of each tree. This examination was done during the early part of the egg-laying period of the hoppers when the panicles were about 8 to 10 or more days old. Two to five days later, the panicles were again examined for nymphal infestation by agitating moderately the panicle for about half a minute and then watching for the nymphs. The purpose of the foregoing examination was to determine from the percentage of infested panicles obtained and relative abundance of the nymphs whether the infestation of each tree was light, moderate or severe (Plate 3, fig. 2).

For equitable and impartial comparison between sprayed and unsprayed trees it was thought best to express the results in terms of yield per panicle; for this reason, it was necessary to know the number of panicles and fruits produced by each tree. With the aid of "hand tally counter," counts of the panicles were made before the opening of the flowers and those of the fruits, when they showed signs of maturity. The counts were repeated once if the panicles or fruits were few and twice if abundant. The data obtained were an average of two or three counts.

DISCUSSION OF RESULTS

First series.—This series was conducted in the early part of November, 1933, on flowers produced by smudging in the latter part of the preceeding month. The trees generally showed sparse flowering with tip-borer infestation ranging from 2 to 90 per cent or an average of 28.4 per cent. No spraying for tip-borer was done in this series because it was not thought at first that this pest would be so severe as to require it. Eleven trees sprayed with soap and seven were used as control. The leafhopper infestation which was determined during the early part of the egg-laying period varied from 1.3 to 2.53 *I. clypealis* and from naught to 0.4 *I. niveosparsus* on the average per panicle per tree (Table 6). The subsequent nymphal infestation was 100 per cent *I. clypealis* for all trees and from 2.0 to 54.0 per cent *I. niveosparsus*. The spraying period was marked by heavy rainfall which frequently interrupted the regularity of spraying intervals.

After the fourth spraying a contrast between the sprayed and check trees was observed since the flowers in the sprayed trees looked fresh while those in the check trees appeared

TABLE 6.—*Results of the first series of soapsud spraying for leafhopper nymphs on mango inflorescence*

Treatment	Variety	Number of panicles	Average number of adults per panicle based on 50-70 panicles		Nymphal infestation based on 100 panicles		Yield	Average yield per panicle	Average yield per panicle per tree
			I. niveosparsus	*I. clypealis*	*I. niveosparsus*	*I. clypealis*			
					Per cent	*Per cent*	*Fruits*	*Fruits*	*Fruits*
Sprayed	Pico	88	0	1.92	8.0	100.00	25	0.28	0.308
	Carabao	216	0	1.54	6.0	100.00	125	0.57	
	do	216	0	2.53	2.0	100.00	13	0.06	
	Pico	888	0	2.32	2.0	100.00	199	0.22	
	Carabao	379	0.13	1.55	10.0	100.00	70	0.18	
	do	370	0.4	2.00	44.0	100.00	32	0.08	
	do	227	0.4	1.40	48.0	100.00	87	0.33	
	do	152	0.4	1.80	54.0	100.00	16	0.10	
	do	415	0	2.50	2.0	100.00	82	0.19	
	Pico	363	0.2	1.60	30.0	100.00	285	0.78	
	Carabao	102	0.3	1.80	40.0	100.00	62	0.60	
Check	Carabao	106	0.18	1.50	24.0	100.00	34	0.32	0.222
	do	109	0.11	1.31	7.0	100.00	64	0.58	
	do	150	0	1.80	3.0	100.00	41	0.27	
	do	301	0	1.30	5.0	100.00	46	0.15	
	do	144	0.38	1.74	38.0	100.00	8	0.05	
	Pico	649	0	1.30	2.0	100.00	0	0	
	Carabao	108	0.21	1.60	21.0	100.00	21	0.19	

blighted. During the opening of most of the flowers and beginning with the date of the fifth spraying it rained continuously for three days; so spraying of a number of trees was delayed 2 or 3 days. This delay gave the hopper nymphs from new hatchings the chance to feed constantly for some days on the sprayed flowers which later also withered and turned black. The ruin of the flowers was believed to be due, in part, to the rain which impaired the activity of the pollinating insects so much that many of the flowers remained unfertilized. Anthracnose disease was suspected as one of the factors responsible for the blighting of the flowers because of favorable weather but isolation studies for its causative agent did not reveal its presence. The fruits that developed to maturity were on the average 0.308 a panicle for each sprayed tree and 0.222 a panicle for each check tree (Table 6). As shown in Table 14 a net return of minus ₱3.14 from the sprayed tree and minus ₱2.84 from the check tree was obtained in this series. From the standpoint of control this series was a failure, although on the average the sprayed panicle gave slightly higher yield than the check panicle.

Second and third series.—These two series were conducted simultaneously in December, 1933, on smudge-produced flowers. They were essentially the same except that the sprays were applied to half crowns in the second series and to the entire crowns in the third series. In both series soap spraying for leafhoppers was preceded by lead arsenate spraying for tip-borer. The seven trees used in the second series nearly all showed profuse flowering with tip-borer infestation on the lead-arsenate-sprayed halves reduced to 1.01–9.60 per cent (Table 3). The sixteen trees used in the third series showed moderate and sparse flowering with tip-borer infestation on lead arsenate-sprayed trees reduced to 1.01–6.30 per cent (Table 4).

The trees used in both series were all severely infested by leafhoppers, the predominating species of which was *I. clypealis* (Tables 7 and 8). Five or six sprayings for the hopper nymphs with soap at intervals of 3 days were of no avail in saving the crop from serious damage as shown by the extremely low yield of the treated trees (Tables 7 and 8) in both series despite the profusion of inflorescence on some of those trees. The destruction of the sprayed inflorescence (Plates 4 and 5) was caused by the heavy migration of young adult hoppers from the unsprayed flowers. The young fliers which need plenty of juice for their full development were voracious suckers of sap from the tissues of the inflorescence. Soapsud spray is powerless in

TABLE 7.—*Results of the second series of spraying for leafhopper nymphs with soapsud (soapsud preceeded by lead arsenate)*

Tree No.	Variety	Number of panicles		Average number of adults per panicle based on 100 panicles		Nymphal infestation based on 100 panicles		Yield		Average yield per panicle		Average yield per panicle per half tree	
		Sprayed	Check	*I. niveosparsus*	*I. clypealis*	*I. niveosparsus*	I. clypealis	Sprayed	Check	Sprayed	Check	Sprayed	Check
						Per cent	*Per cent*	*Fruits*	*Fruits*	*Fruits*	*Fruits*	*Fruits*	*Fruits*
6	Pico	185	166	0.06	4.92	1.40	100	13	8	0.07	0.04		
7	do	860	1,053	0.16	3.10	1.2	100	8	6	0.009	0.005		
10	Carabao	1,026	762	0.31	2.85	62.0	100	9	0	0.008	0		
11	do	455	746	0.16	2.82	20.0	100	2	2	0.004	0.002	0.038	0.006
13	do	1,729	1,665	0.08	4.90	20.0	100	10	0	0.005	0		
14	do	188	166	0.06	2.64	82.0	100	10	0	0.05	0		
16	Pico	520	665	0.29	3.32	25.0	100	6	0	0.01	0		

TABLE 8.—*Results of the third series of soapsuds spraying for leafhopper nymphs on mango inflorescense (soapsud preceded by lead arsenate)*

Treatment	Tree No.	Variety	Number of panicles produced	Average number of adults per panicle based on 100 panicles		Nymphal infestation based on 100 panicles		Yield	Average yield per panicle	
				I. niveosparsus	*I. clypealis*	*I. niveosparsus*	*I. clypealis*			
						Per cent	*Per cent*	*Fruits*	*Fruits*	
Sprayed	2	Carabao	413	0.04	4.18	41.0	100	10	0.02	0.05
	4	do	329	0.08	3.53	29.0	100	11	0.03	
	5	do	581	0.08	5.40	44.0	100	1	0.001	
	9	do	346	0	3.24	14.0	100	52	0.15	
	12	do	337	0.19	3.04	64.0	100	16	0.04	
	17	do	153	0	2.10	6.0	100	6	0.03	
	19	do	407	0.14	3.42	76.0	100	10	0.02	
	24	do	251	0.14	2.04	62.0	100	21	0.08	
	26	do	148	0.02	1.86	24.0	100	12	0.08	
	29	do	467	0.56	2.82	46.0	100	7	0.01	
	30	do	362	0.04	2.89	20.0	100	9	0.02	
	27	do	117	0.02	1.80	4.0	100	15	0.128	
Check	18	do	118	0.20	2.20	19.0	100	6	0.05	0.03
	21	do	446	0.04	1.92	27.0	100	3	0.006	
	23	do	440	0.06	2.44	12.0	100	5	0.011	
	31	do	107	0.34	4.10	45.0	100	6	0.056	

killing them. When the inflorescence in which they were bred, withered and became sapless, they flew to the fresh inflorescence which they also destroyed later. The records of migration of young adult fliers from unsprayed halves to sprayed halves of four trees based on 50 panicles per tree are shown in Table 9. Those records were started when most of the unsprayed inflorescences were withering and while the sprayed inflorescence still showed signs of freshness. During this time the hoppers were fast shedding off their last nymphal skin. In Table 9, it will be seen that on December 20, the records started with an average of 48.2 young adults on the check flowers and only 2.2 young adults on the sprayed flowers; then the figures rose on December 23, to 231 for the unsprayed and 78.7 for the sprayed; finally, they went down on December 30 to 1.9 for the unsprayed and 9.2 for the sprayed, showing that the hoppers had dispersed and had moved in various directions to other trees. From these observations, it would not, therefore, be advisable to use many check trees in spraying experiments for leafhopper control because they make good sources of reinfestation for the sprayed flowers. These two series of experiments were also a total failure. According to Table 14 an average net return of minus

TABLE 9.—*Showing the rate of migration of young adult leafhoppers from the unsprayed to sprayed inflorescences of four trees used in the fourth series and also their dispersion when both sprayed and unsprayed flowers withered and became sapless (based on 50 panicles per tree).*

Tree No.	December 20		December 23		December 27		December 30	
	Check	Sprayed	Check	Sprayed	Check	Sprayed	Check	Sprayed
	Leaf-hoppers	*Leaf-hoppers*	*Leaf-hoppers*	*Leaf-hoppers*	*Leaf-hoppers*	*Leaf-hoppers*	*Leaf-hoppers*	*Leaf-hoppers*
7	41	2.5	231	78	18.6	47.8	1.2	10
10	68	2.0	242	67	17.5	51.0	2.3	7
11	52	2.5	253	109	41.0	103.0	1.4	12
13	32	1.8	198	61	26.5	42.7	3.0	8
Average	48.2	2.2	231	78.7	25.9	61.1	1.9	9.2

₱7.89 was obtained from a sprayed tree and minus ₱3.78 from a check tree.

Fourth and fifth series.—These two series were conducted simultaneously in January, 1934, on smudge-produced flowers. The trees used in these two series showed profuse, moderate and sparse flowering. The trees in the fourth series, not being sprayed for tip-borer showed 26.0 per cent infestation while those in the fifth series, being sprayed for tip-borer with lead arsenate showed on the average only about 4.7 per cent infestation. The infestation by the leafhopper nymphs, of which the preponderant species was *I. clypealis,* was severe (Tables 10 and 11).

Five to seven sprayings of soapsuds gave a yield of 0.384 fruit in the fourth series (Table 10) and 0.415 fruit in the fifth series (Table 11) on the average per panicle per tree. The two check trees used for both series yielded only 0.015 fruit on the average per panicle per tree.

A severe fruit-shedding which started from the time the fruits were set to the time they matured had been observed to be one of the causes of the great reduction in the expected yield in both series. According to Table 12 only 1.87 to 5.0 per cent of the fruits left on the panicles a week after setting developed to maturity. Fruit-shedding was caused by various factors. The natural fruit-shedding which is frequently observed on various fruit trees was believed to be due to inadequate nourishment for a great number of growing fruits, as a result of deficient soil nutrition. The shedding of a great number of mango fruits in these two series was due in part to the reinfestation of leaf-

TABLE 10.—*Results of the fourth series of soapsud spraying for leafhoppers on mango inflorescence*

Treatment	Tree No.	Variety	Number of panicles	Average number of adult hoppers per panicle based on 100 panicles		Nymphal infestation		Yield	Average yield per panicle	Average yield per panicle per tree
				I. niveosparsus	*I. clypealis*	*I. niveosparsus*	*I. clypealis*			
						Per cent	*Per cent*	*Fruits*	*Fruits*	*Fruits*
Sprayed	4	Carabao	273	0.89	1.17	20.0	100	66	0.24	0.384
	5	do	123	0.34	1.85	14.0	100	23	0.18	
	7	do	580	0.04	2.30	10.0	100	53	0.09	
	13	do	646	0.02	2.70	4.0	100	104	0.16	
	14	do	741	0.07	2.64	36.0	100	157	0.21	
	15	do	560	0.03	2.02	9.0	100	112	0.20	
	20	do	152	0.10	1.75	32.0	100	85	0.55	
	21	do	145	0.50	1.82	52.0	100	41	0.28	
	26	do	174	0.02	1.67	28.0	100	68	0.39	
	27	do	66	0.01	1.25	6.0	100	31	0.46	
	29		247	0.01	1.95	4.0	100	36	0.14	
	31	do	2,183	0.32	3.21	30.0	100	1,170	0.53	
	33	do	190	0.01	2.10	5.0	100	62	0.32	
	37	Pico	640	0.02	1.72	10.0	100	547	0.85	
	38	Carabao	1,627	0.02	2.32	12.0	100	892	0.54	
	41	Pico	143			14.0	100	180	1.25	
	42	Carabao	267	0.03	2.02	12.0	100	79	0.29	
	43	do	152	0.10	1.75	32.0	100	51	0.33	
	49	do	72					22	0.30	
Check	10	Carabao	679	0.04	2.90	20.0	100	1	0.001	0.015
	16	do	1,724	0.21	2.67	32.0	100	63	0.03	

TABLE 11.—*Results of the fifth series of soapsud spraying for leafhoppers on mango inflorescence*

Treatment	Tree No.	Variety	Number of panicles	Average number of adult hoppers per panicle based on 100 panicles		Nymphal infestation		Yield	Average yield per panicle	Average yield per panicle per tree
				I. niveosparsus	*I. clypealis*	*I. niveosparsus*	*I. clypealis*			
						Per cent	*Per cent*	*Fruits*	*Fruits*	*Fruits*
Sprayed	3	Carabao	386	0.21	1.25	38.0	100	244	0.63	0.417
	6	do	385	0.08	4.14	18.0	100	24	0.06	
	11	do	254	0.12	1.70	14.0	100	61	0.24	
	12	do	280	0.03	2.14	14.0	100	89	0.31	
	17	do	1,553	0.02	3.02	8.0	100	552	0.35	
	18	do	2,564	0.06	2.61	24.0	100	1,484	0.58	
	19	do	1,414	0.40	2.01	64.0	100	213	0.15	
	23	do	1,696	0.20	2.55	68.0	100	791	0.47	
	24	do	945	0.27	2.00	36.0	100	501	0.53	
	30	Pico	645	0.60	1.70	72.0	100	608	0.94	
	34	Carabao	779	0.55	3.20	18.0	100	312	0.40	
	35	Pico	1,464	0.21	2.33	32.0	100	621	0.42	
	40	Carabao	957	0.06	1.82	24.0	100	330	0.34	
Check	10	do	679	0.04	2.90	20.0	100	1	0.001	0.015
	16	do	1,724	0.21	2.67	32.0	100	63	0.03	

TABLE. 12.—*Showing the extent of fruit-shedding in some trees used in the fourth and fifth series of spraying experiments for the control of leafhoppers*

Tree number	Number of panicles tagged	Number of fruits on 40 panicles a week after setting [1]		Number of fruits left on the panicle after 7 weeks		
		Range	Average	Range	Average	*Per cent*
3	40	1–32	12.00	0–3	0.600	5.00
12	40	1–32	9.00	0–2	0.350	3.90
13	40	1–29	8.35	0–3	0.320	3.80
14	40	1–54	13.60	0–2	0.400	2.94
15	40	1–43	13.20	0–2	0.300	2.27
17	40	1–48	13.20	0–2	0.250	1.89
18	40	2–51	14.55	0–4	0.700	4.80
23	40	1–47	14.72	0–2	0.275	1.87
24	40	1–25	13.00	0–2	0.620	4.76
31	40	1–30	12.40	0–4	0.400	3.20

[1] A week after the mango fruits had set, forty panicles from each tree were tagged and then the number of fruits were counted. After seven weeks the number of fruits on the tagged panicles were counted again to ascertain how many were left on the panicle.

hoppers, and mainly to the combined attack of caterpillars, beetles and fruit-fly maggots. Despite the severe fruit-shedding, the sprayed trees in both series still showed much heavier yield in fruits (Plate 6) than the checks.

Computing for net returns (Table 14), ₱1.46 was obtained from the sprayed trees of the fourth series and ₱6.20 from those of the fifth series while minus ₱2.79 was obtained from the check trees. Although no distinct difference in average yield in fruits per panicle per tree may be noted between the two series (Tables 10 and 11) according to the figures above they differ markedly in financial net returns, being higher in the fifth than in the fourth series. This was probably due largely to the fact that in the fifth series more trees with profuse flowering were used, and also, in part, to the reduced number of tip-borer infested panicles as a result of lead arsenate treatment.

Sixth series.—This series was conducted on smudge-produced flowers[4] in April, 1934, in another part of the plantation about a kilometer away from the place where the first five series were

[4] The normal flowering season of mango ordinarily covers a period of from February to April. Forcing trees to flower by smudging is not usually practiced during this period. Unexpectedly, however, about two-thirds of the trees in the plantation produced the leaf shoots instead of the flower flush in February and March, 1934. A number of those trees with matured leaves were then smudged for a few days and produced the flowers which were used in the sixth series.

performed. No spraying for tip-borer was done in this series because this insect was scarse during this period. Infestation by the leafhopper nymphs was in general moderate.

The five-spray schedule at intervals of 3 days was followed faithfully in this series. As a result of the treatment the sprayed trees showed heavier setting of fruits than the checks but when the fruits were approaching maturity in June, 1934, they were attacked by beetles of various species[5], among which the following were observed to be destructive:

1. *Protaetia bifenestrata* Chevr.
2. *Protaetia philippinensis* Fab.
3. *Protaetia* spp. (2 kinds).

(1–3: Cetanidæ)

4. *Parastasia canaliculata* West (Scarabaeidae)
5. *Popillia cetrata* Newm. (Scarabaeidae)
6. *Phytorus lineolatus* Weise (Chrysomelidae)
7. *Monolepta bifasciata* Hornst. (Chrysomelidae)

The beetles attacked the fruits by eating up portions of the rind and flesh (Plate 7, figs. 1 and 2). Sometimes two or three species of the beetles were seen attacking a fruit at one time. Owing to the preponderance of *Phytorus lineolatus* it was observed to be more destructive than any of the other species of the beetles. Rot organisms and flies of the genera (*Drosophila* and *Chaetodacus*) followed the attack of the beetles, as a result of which the fruits fell off. Nearly all of the maturing fruits that were shed showed the attack of the beetles. The number of fallen fruits counted were about two times the number actually harvested.

Notwithstanding the severe attack of beetles more fruits were harvested from the treated trees than from the check trees (Table 13). The sprayed trees gave an average yield of 0.49 fruit per panicle while the check trees only 0.10 fruit per panicle. Owing to the low cost of mangoes in June, being only two pesos per *kaing* of 200 carabao fruits and one peso a *kaing* of 300 pico fruits, no profit was realized from this series. As shown in Table 14, a net return of minus ₱1.43 from the sprayed and minus ₱1.43 from the check was obtained.

Seventh series.—This series was conducted in Muntinlupa Plantation from November, 1934, to January, 1935, on smudge-produced flowers. The plantation, was, for the last six years, the focus of severe leaf hopper infestation in the locality. Owing

[5] The species of beetles herein listed were determined by comparing the specimens with those in the National Museum, Bureau of Science, Manila.

TABLE 13.—*Results of the sixth series of soapsud spraying for the control of leadhoppers on mango inflorescence*

Treatment	Tree No.	Variety	Number of panicles	Yield	Average yield per panicle	Average yield per panicle per tree
				Fruits	*Fruits*	*Fruits*
Sprayed	1	Carabao	155	106	0.68	0.49
	5	do	451	340	0.75	
	6	do	122	77	0.63	
	8	do	562	482	0.85	
	9	Pico	180	129	0.72	
	37	Carabao	183	31	0.16	
	39	do	150	42	0.28	
	88	do	154	53	0.34	
	109	do	96	18	0.18	
	127	do	153	58	0.37	
Check	4	do	154	0	0	0.10
	86	Pico	301	63	0.20	

to the strong typhoons which occurred in mid-October, 1934, the leafhopper population of the plantation as revealed by an examination of the foliage of several trees prior to spraying, was sparse. The manager of the plantation insisted on spraying all the available trees in flower with soap, in spite of the light leafhopper infestation shown by an examination of the inflorescences, because he feared that they might be the source of serious infestation for the succeeding normal season crop. Spraying more than 20 trees was then started using 0.4 per cent solution of the soap that was obtained from a factory in Pasay, but it had to be discontinued after the third application at intervals of 3 days because it was observed that the soap spray was injurious to the flowers. The injury was noticed only after an examination of several inflorescences which showed premature withering of the flowers but which had few or no hopper nymphs. It was not known to what properties of the soap the injury could be attributed since in the analysis made by the Chemistry Section of the Bureau of Plant Industry the sample contained practically no free alkali.

All the trees used in this series produced the fruits only on top of the trees which, being about 15 to 20 meters high, could hardly be reached by the spray. This, therefore, could be taken as another indication that the soap used was injurious to the flowers. The yield obtained was on the average about one and one-half "kaings" per tree.

TABLE 14.—*Showing the expenses incurred and net returns obtained in each of the six series of spraying experiments for the control of leafhoppers on mango inflorescence*

Series	Number of trees used		Value of the crop [a]		Total expenses [b]		Average value of the crop		Average expenses		Average net returns	
	Sprayed	Cheks	Sprayed	Checks	Sprayed	Checks	Sprayed	Checks	Sprayed	Checks	Sprayed	Check
			Pesos	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*	*Pesos*
First	11	7	17.13	8.56	61.79	28.43	2.47	1.22	5.61	4.06	−3.14	−2.84
Second	12	4	1.64	0.29	70.83	16.02	0.14	0.07	5.90	4.01	−5.76	−3.98
Third	3.5	3.5	6.80	0.80	34.28	14.04	1.90	0.23	9.79	4.01	−7.89	−3.78
Fourth	19	2	132.98	2.56	105.21	8.13	6.99	1.28	5.53	4.07	+1.46	−2.79
Fifth	13	2	202.47	2.56	121.84	8.13	15.57	1.28	9.37	4.07	+6.20	−2.79
Sixth	10	2	12.07	0.21	11.67	0.08	1.25	0.11	2.67	1.54	−1.43	−1.43

[a] The off-season harvests from the first series were sold at ₱8 a *kaing* of 200 carabao fruits and ₱4.50 a *kaing* of 300 pico fruits while the crop obtained from the sixth series was sold at ₱2 a *kaing* of carabao fruits and ₱1 a *kaing* of pico fruits.

[b] Total expenses include the following:

1. Smudging—₱4 per tree in the first five series and ₱1.50 per tree in the sixth series. These figures were obtained from Mr. Sixto Sison, Superintendent of the station.
2. Spraying—
   a. Sprays—lead arsenate, ₱0.52 a kilo, soap, ₱0.23 a kilo.
   b. Labor (5 laborers, four working with two pumps, one supplying water sprayed two trees at a time at ₱4 a day of 9 working hours or ₱2 per tree a day. Expenses for labor were computed from the amount of time spent for spraying).
3. Harvesting—0.25 peso a *kaing* of 200 fruits of the Carabao variety or of 300 fruits of the Pico variety.
4. Transportation—The cost of transportation of mangos to Manila by truck is ₱0.15 a *kaing*.

PHOTOTROPIC RESPONSE OF MANGO LEAFHOPPERS, TIP-BORER AND OTHER INSECTS

The possibility of utilizing light traps for the control of mango leafhoppers was pointed out by Merino(15) in 1929. Serrano and Palo(21) reported positive evidence that these insects are attracted to artificial light. The present knowledge on light-trapping of mango insects in the Philippines is inadequate and the data so far obtained on this were insufficient to encourage the use of light traps for the control of these insects. The observations and data recorded in this paper may add further information to what is already known about this subject.

The following experiments and observations on the phototropic response of mango leafhoppers and other insects were performed in January, 1934, in Novaliches Mango Plantation. It was originally planned in this experiment to use variously colored lights for trapping the insects but since facilities for their installation were inadequate the writers had to resort to the use of only two kinds of lamps with lights of different intensity. Two Coleman incandescent gas lamps each of 300 candle power and two ordinary Dietz lanterns were each placed in a basin containing water to which sufficient kerosene to cover the entire surface of the water was added. A basin containing the Coleman lamp and another containing the Dietz lantern were placed in opposite directions on lateral branches, about six meters high [6] of a tree which showed severe leafhopper infestation. The other pair of lamps was placed in like manner in another severely infested tree. The two lamps in each tree were exchanged places every night. The lamps were lighted at 6 P. M. and extinguished at 5 A. M. A supplementary experiment in which five Dietz lanterns were used as light traps in each of the five mango trees which showed high intensity of leafhopper attack was also conducted. The average daily capture of leafhoppers, tip-borer moths and other insects are shown in Tables 15 and 16.

From the study of Table 15 it is seen that more insects are attracted every night to the Coleman lamp than to the Dietz lantern. As shown by the average capture for a period of from January 9 to January 27 the Coleman lamp attracted more than two times as much *I. niveosparsus* and slightly less than two

[6] For trees about 12 to 15 meters high, light traps set on lateral branches about six meters high had been found previously by trials to capture more leafhoppers than those placed either below this height or on one-meter-high stands several meters away from the tree.

TABLE 15.—*Showing the average daily response of leafhoppers, tip-borrers and other insects to Dietz and Coleman lights*[1] *and to weather factors*

Date (1934)	*I. niveosparsus*		*I. clypealis*		Tip-borer moth		Other moths		Flies and mosquitoes		Hymenoptera		Orthoptera		Coleoptera		Other leafhoppers (Homoptera)	
	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C
January 9	114	345	27	31	11	12	38	324	27	41	5	14	7	7				
January 10	265	388	19	32	8	12	71	247	42	61	11	6	10	13	7	33	9	9
January 11	266	522	74	86	6	5	85	94	166	180	5	8	13	12	4	9	7	8
January 12	21	29	12	14	7	7	98	131	57	72	6	4	3	4	13	22	5	2
January 13	157	265	27	38	3	7	102	188	29	43	4	2	3	8	4	9	1	2
January 14	135	229	82	84	4	8	135	207	37	55	4	6	6	5	7	7	5	6
January 15	102	245	56	87	4	6	72	201	20	40	2	6	4	28	6	7	3	6
January 16	131	272	81	93	5	5	127	184	18	38	5	8	18	8	6	9	7	4
January 17	34	88	40	82	2	6	57	120	21	35	4	7	9	30	4	7	2	7
January 18	14	192	24	16	1	4	17	215	10	36	5	6	4	7	4	7	1	6
January 19	15	76	14	33	1	4	29	128	15	34	1	4	2	14	3	7	4	7
January 20	23	223	65	173	1	9	31	315	20	42	1	5	2	8	4	11	3	7
January 21	20	98	23	80	16	4	32	248	16	255	30	10	2	4	3	10	0	2
January 22	13	84	11	106	2	8	11	250	10	30	1	7	1	4	1	4	1	3
January 23	8	37	25	28	1	2	23	122	10	29	2	2	0	3	5	6	1	3
January 24	38	81	26	57	1	6	32	145	11	22	2	4	3	4	2	6	1	3
January 25	27	58	22	62	1	4	36	98	13	28	3	4	0	3	1	6	2	3
January 26	23	84	42	70	1	3	42	114	14	21	1	2	2	4	4	8	2	5
January 27	17	38	13	27	1	2	24	57	10	13	2	2	3	3	5	5	2	3
Average	74.9	176.5	35.9	63.1	4.0	6.0	55.8	173.0	28.7	56.5	5.0	5.6	4.7	7.3	4.8	10.1	3.1	4.7

[1] Two Coleman (C) and 2 Dietz (D) lanterns were used. Conducted on two trees when panicles were almost fully developed. Height—6 meters. One (D) on one side of tree and a (C) on other side. Places exchanged every day.

TABLE 15.—*Showing the average daily response of leafhoppers, tip-borers and other insects to Dietz and Coleman lights and to weather factors*—Continued

Date 1934	Mean hourly temperature (6 P. M.—5 A. M.)	Mean hourly humidity (6 P. M.—5 A. M.)	General daily remark on weather conditions	Phases of the moon
	°C.	*Per cent*		
January 9	22.5	86.9	Fair	
January 10	24.6	90.3	Cloudy	
January 11	24.4	90.5	Rain for 20 minutes before 9 P. M.	
January 12	23.3	96.0	Heavy rain in the morning; squally and drizzly nights	
January 13	24.6	92.6	Shower from 1:30 to 3:30 P. M.	
January 14	23.3	88.6	Clear	
January 15	22.5	94.5	Rain for one-half hour before 3 P. M.; shower at night	New moon.
January 16	23.7	85.5	Fair	
January 17	22.7	85.5	Fair	
January 18	23.3	87.5	Fair	
January 19	23.5	84.5	Fair	
January 20	23.6	88.0	Fair	
January 21			Rain for one-half hour in the afternoon	First quarter.
January 22	20.2	79.5	Fair	
January 23	20.5	75.9	Fair	
January 24	19.55	76.1	Fair	
January 25	21.16	70.7	Fair	
January 26	20.93	74.8	Fair	
January 27	19.6	87.7	Fair	
Average				

times as much *I. clypealis* as the Dietz lantern. *I. clypealis* was somewhat indifferent in its response to the lights used, because, despite its great preponderance in the trees where the traps were set, more *I. niveosparsus* than this species were always caught (Tables 15 and 16). It is largely possible that a certain colored light is necessary for greater attraction of *I. clypealis*. As shown in Tables 15 and 16 the tip-borer adults were not also highly positively phototropic. Various species of other insects falling under different groups were caught but of these the lepidopterous group were best represented not only in number of species but also in many cases in number of individuals of each species. From the viewpoint of control on commercial basis, this is economically beneficial because the caterpillars of many of those lepidopterous insects are destructive to the mango inflorescences and newly-set fruits.

The response of insects to artificial lights is influenced by certain environmental factors, among which, temperature, humidity, wind velocity, rainfall, and lunar phases may be considered important. It is difficult to correlate any of these factors with the nightly collections of insects in Tables 15 and 16 because they all acted at one and the same time and also because they showed wide range of variations which were not uniform for all nights. The existing temperature, humidity and air movement may be favorable for the attraction of insects, but if the night is bright, not many insects will be caught. From the data presented in Tables 15 and 16 it is shown that high attraction of leafhoppers took place during the period of from January 9 to January 16, except on January 12 when the mean hourly humidity was 96.0 per cent and the night rather drizzly or squally. During the period of high attraction the nights were dark, the humidity was rather high, and the mean hourly temperature was between 22.5°C. and almost 25°C. It was not possible, however, to determine from these data how much of the attraction was due to dark night, to humidity and to temperature.

The daily capture from January 17 to January 27 (Tables 15 and 16) were much less than those from January 9 to January 16. Lower mean hourly temperature and humidity and bright nights acting together were responsible for this low attraction of leafhoppres.

More studies on light trapping of leafhoppers and other insects attacking mango, especially, with the use of colored lights are necessary in order to ascertain further if their control by this

TABLE 16.—*Showing the average daily attraction of leafhoppers, tip-borers and other insects to Dietz lights, and to daily weather factors*

Date (1934)	*I. niveosparsus*	*I. clypealis*	Tip-borer moth	Other moths	Flies and mosquitoes	Hymenoptera	Orthoptera	Coleoptera	Other hoppers (Homoptera)	Mean hourly temperature (6 P. M. —5 A. M.)	Mean hourly humidity (6 P. M. —5 A. M.)	General daily remark on weather conditions	Phases of the moon
										°C.	*Per cent*		
January 9	128	22	11	56	34	6	7			22.5	86.9	Fair	
January 10	275	24	9	77	36	10	9	11	8	24.6	90.3	Cloudy	
January 11	235	59	6	123	145	8	13	8	8	24.4	90.5	Rain for 20 minutes before 9. P. M.	
January 12	64	45	5	85	88	4	3	14	4	23.3	96.0	Heavy rain in the morning; squally and drizzly night.	
January 13	119	57	4	126	24	5	3	5	4	24.6	92.6	Shower from 1.30 to 3.30 P. M.	
January 14	112	47	4	104	26	5	5	7	4	23.3	88.6	Fair	New moon.
January 15	82	52	5	100	25	3	6	6	3	22.5	94.5	Rain for one-half hour before 3 P. M., shower at night.	
January 16	79	54	4	89	25	5	8	5	7	23.7	85.5	Fair	
January 17	55	32	4	47	17	4	2	4	3	22.7	85.5	Fair	
January 18	54	25	4	63	17	4	2	4	4	23.3	87.5	Fair	
January 19	39	26	2	48	23	5	2	5	3	23.5	84.5	Fair	
January 20	40	65	2	61	21	5	4	5	3	23.6	88.0	Fair	
January 21	18	44	6	42	23	3	2	4	3			Rain for one-half hour in the afternoon.	First quarter.
January 22	11	19	1	23	14	1	2	4	2	20.2	79.5	Fair	
January 23	13	34	1	27	13	2	1	3	4	20.5	75.9	Fair	
January 24	35	31	2	32	12	2	2	1	2	19.55	76.1	Fair	
January 25	34	39	1	33	17	2	2	2	2	21.16	70.7	Fair	
January 26	29	40	2	31	12	2	1	2	3	20.93	74.8	Fair	
January 27	21	22	1	34	13	2	2	4	2	19.6	87.7	Fair	

method is possible. The daily capture shown in Tables 15 and 16, being generally low, does not give sufficient assurance that the use of either Dietz or Coleman lanterns for the control of leafhoppers and tip-borer will be beneficial. Their use may, however, help minimize the volume of leafhopper and tip-borer infestation if started when the inflorescence buds are bursting; and for the purpose of catching other mango insects injurious to the inflorescences and newly-set fruits it should be continued until the flowers have shed their petals. Light trapping with the use of Dietz or Coleman lamp is an expensive operation and it cannot be advocated at present for the control of mango insects.

SUMMARY AND CONCLUSIONS

The combined attack of leafhoppers (*Idiocerus niveosparsus* Leth. and *Idiocerus clypealis* Leth.) and tip-borer (*Chlumetia transversa* Wlk.) on mango inflorescence in the Philippine has occasioned enormous losses of the crop during the last five or six years. These pests are widespread in all of the principal mango-growing regions in the Philippines.

The tip-borer pest, which is caused by the larva of *Chlumetia transversa,* appears, to be most active only when the mango trees are in leaf or flower flush. It was observed, however, to be more destructive to the off-season flowers than to the normal season flowers. The attack of this pest on the leaf shoots produced during the rainy months is sometimes severe.

Chlumetia transversa is a grayish black moth, 8 to 10 millimeters long having a wing spread of about 16 to 18 millimeters. The forewings are crossed by wavy black lines at basal, subbasal, medial, and discal parts, and a row of linear black spots at the margin. The male and female are alike in body characters, except that the male has a black crest on from the second to the fourth abdominal segment. The eggs are creamy white, ellipsoidal, 1.2 millimeters long and 0.74 millimeter thick. They are laid singly on the flower stem and young shoots and hatch in about 4.1 days on the average. The newly-hatched larva feeds for a certain period on the soft tender tissues before it bores into the panicle or shoot. The larva is inside the tender terminal growth during the greater part of its life and comes out of it only when it attacks a fresh growth. The pupal stage is spent in the soil. From the data obtained the life cycle of

this insect from the egg to the adult stage is 26.5 days on the average.

The application of 0.5 per cent lead arsenate at intervals of 3 or 4 days beginning when the panicles are about 2 to 6 centimeters long was found to aid greatly in reducing the ravages of the tip-borer pest. This control was, however, found useless in increasing the crop unless the leafhoppers which are always found associated with the tip-borer pest are also satisfactorily controlled.

The results of seven series of spraying experiments to control the leafhoppers with soap solution of 0.5 and 0.4 per cent concentrations are discussed.

While laundry soaps are effective in killing the leafhopper nymphs, not all solutions of soaps from different factories are safe to apply to the mango flowers owing to their variability in composition. The solution of the soap obtained from the Philippine Manufacturing Company in Manila was found less injurious to the flowers while that of the soap obtained from the factory in Pasay, Rizal, was highly injurious. Even with the use of soap, least injurious to the flowers, it cannot be assured that there would be profit because of the presence of many factors which may upset the yield. Heavy fruit-shedding and the severe attack of other mango insects, such as caterpillars and beetles on flowers and fruits and maggots on fruits are among those factors. In spraying for profit, it is, therefore, very necessary to bring as many of those factors under control as possible.

In extreme cases of leafhopper infestation spraying with 0.4 or 0.5 per cent soapsuds at 3 days interval has been observed to be of little or no value in preventing the damage of the crop since between applications of the spray, the inflorescences are often seriously injured by the nymphs from new hatchings. This, therefore, necessitates more frequent spraying which may be objectionable because it is tedious, expensive, and likely to impair fertilization of the flowers.

Thorough drenching of the inflorescences is an important requisite in spraying for leafhopper nymphs with soap solution. A profusely-flowered tree in Novaliches Mango Plantation required from 350 to 600 liters of the soapsuds discharged from a hand pump in from 3 to 4 hours to thoroughly wet its inflo-

rescenses during each spraying. Even with the use of such large amount of spray, still some more nymphs may be observed unharmed, especially on parts of the tree where blossoming is thick.

For reasons indicated above, spraying for leafhoppers on mango inflorescence with soap solution should be undertaken with great caution. Owing to the sensitiveness of the mango flowers, especially while open, stress should be placed upon the importance of using the proper kind of soap that will cause the least injury to the flowers. Before using the soap it should be tested first on a number of healthy inflorescences with open flowers. If it does not cause injury to the flowers after 3 to 5 days it might be safe to use it for large-scale spraying for leafhoppers.

The other methods of controlling the leafhoppers on mango inflorescence should be tried. It is highly probable that better results will be obtained with the use of certain dusts deleterious to these insects if applied during the abundance of the adults when the trees are not in flower. The natural enemies of the leafhoppers should also be studied and the possibility of using them for their control should be investigated.

The phototropic response of leafhoppers, tip-borers and other mango insects was studied. Although the leafhoppers and tip-borers exhibit positive phototropism, the attraction of these pests to either an ordinary light from Dietz lantern or a powerful light from Coleman lamp is not sufficiently high to warrant the use of any of these lamps as light traps for the control of these pests. Their use will, however, aid greatly in minimizing the infestation if set during the flowering period. Dark nights and calm weather with mean humidity of around 90.0 per cent seem to favor large attraction of these insects.

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ILLUSTRATIONS

Plate 1

Fig. 1. Inflorescences of Pico mango showing the attack of the tip-borer pest. Note the presence of the larva of *Chlumetia transversa* in the cavity in each inflorescence; about ½ natural size.

2. A twig of Carabao mango showing the tip-borer infested shoots. Note the shriveled condition of the attacked shoots; about "X" ⅓. (The illustrations in this plate are Bureau of Science photographs obtained from Mr. F. B. Serrano.)

Plate 2

Fig. 1. A portion of the flower stem showing an egg deposited by the female moth, *Chlumetia transversa;* about × 3.

2. *Chlumetia transversa,* newly-hatched larva; about × 3.
3. *Chlumetia transversa,* mature larva; about × 3.
4. *Chlumetia transversa,* pupa; about × 3.
5. *Chlumetia transversa,* male moth; about × 3.
6. *Chlumetia transversa,* female moth; about × 3.
7. *Chelonus* sp., a hymenopterous parasite of the larva of *Chlumetia transversa;* about × 3.

Plate 3

Fig. 1. A healthy carabao mango inflorescence; about × ½.

2. A carabao mango inflorescence badly attacked by leaf-hopper nymphs. Note the presence of numerous leaf-hopper nymphs on the peduncle and laterals of the inflorescence; about × ½.

Plate 4

Fig. 1. A Carabao tree in full bloom with right half sprayed with lead arsenate for tip-borer followed by soap spraying of leafhopper nymphs, leaving the left half unsprayed as check. Note the difference between the sprayed and unsprayed halves. The sprayed flowers looked fresh and healthy while the unsprayed inflorescences appeared black due to the severe leafhopper infestation; × 1/80. (Photographed after the fourth spraying.)

2. The same tree as in fig. 1, with the check inflorescences completely destroyed by the leaf-hopper nymphs and with about two-thirds of the sprayed inflorescences destroyed by the young adult leafhoppers which had migrated from the unspread half; about 1/80. (Photographed a week after the fifth spraying.)

Plate 5

Fig. 1. A carabao tree showing the complete ruin of both the unsprayed flowers (left half) and the inflorescences sprayed with lead ar-

senate for tip-borer followed by soap spraying for leafhopper nymphs (right half). The destruction of the sprayed half was also due to the attack of young leafhopper adults which had migrated from the check flowers; about × 1/80.

FIG. 2. A carabao tree with entire crown sprayed with lead arsenate for tip-borer followed by soap spraying for leafhopper nymphs. Note that about one-half of the inflorescences had already been destroyed by the young leafhopper adults which had migrated from the unsprayed trees; about × 1/80.

PLATE 6

FIG. 1. A carabao tree used in the fifth series of soap spraying experiments showing moderate number of mature fruits; about × 1/60.

2. One of the two check trees used in the fifth series. On close observation of the picture, some of the peduncles with laterals already detached may be seen; about ×1/70.

PLATE 7

FIG. 1. A carabao mango showing the early stage of the attack of *Phytorus lineolatus*. Note the presence of the beetle on the eaten-up portions of the rind of the fruit; about × 1½.

2. Carabao mango fruits badly attacked by *Phytorus lineolatus*. Note the amount of eaten-up rind and flesh of the fruits and the sign of rotting along the edges of eaten-up areas; slightly less than natural size.

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PLATE 1.

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PLATE 2.

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PLATE 3.

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PLATE 4.

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PLATE 5.

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PLATE 6.

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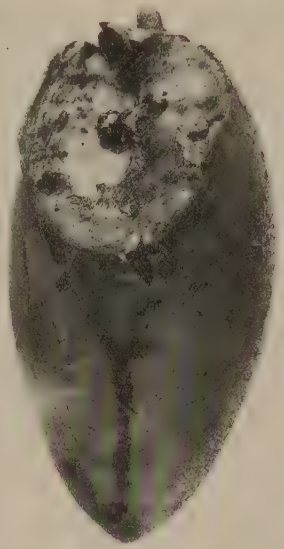

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PLATE 7.

PRELIMINARY STUDY ON THE FIRE-HOLDING CAPACITY OF PHILIPPINE-GROWN CIGAR LEAF WRAPPERS

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ONE PLATE AND TWO TEXT FIGURES

One of the most important qualities of a tobacco leaf especially when intended for use as wrapper is its capacity to hold fire. A method of determining this quality, which has long been in use, consists of burning the leaf by means of a lighted cigar or a slow burning match and noting the number of seconds it continues to glow. This method is not very reliable because of the fact that even with a single leaf the variation is so great that little reliance can be placed upon the results except in a general way. The study here reported is an attempt to apply a more exact method of determining the fire-holding capacity of wrappers, based essentially on the area of leaf burnt. This method was reported by Garner (1907).

MATERIALS AND METHODS

The essential part of the apparatus is the form used to hold the leaf. This is cylindrical, of well seasoned wood $5\frac{3}{8}$ inches in length, $\frac{3}{4}$ inch in diameter at one end, and tapering slightly at the other end. Through the larger end of the cylinder, a $\frac{3}{8}$ inch hole was bored to a depth of $4\frac{3}{4}$ inches and the shell thus formed was separated into six equal segments by sawing to the same depth of $4\frac{3}{4}$ inches. A portion $1\frac{1}{2}$ inches from the smaller end was reduced in diameter so as to fit evenly with the sides of a glass receiver described below, the shoulder thus formed corresponding in depth to the thickness of the wall of the glass receiver. A plug for the larger end of the form was made of such diameter that when inserted in place, the form would assume its original diameter. The receiver for the form was made by drawing out one end of a short piece of glass tubing, the dimensions of which conformed to the dimensions of the wooden form. The glass tubing used had an internal diameter of 14

mm. and an external diameter of 18 mm. The smaller end of the receiver was fitted with a soft cork by means of which it was connected with the other portion of the apparatus.

The wrappers which were to be used in the experiment were first sprayed with water to make them workable. Each wrapper was cut into a form similar to the right-hand or left-hand wrappers usually used in the manufacture of cigars. The plug was inserted in the hole in the bigger end of the wood form. A wrapper was rolled around the form by first pasting the overlapping portion. At the end of the process, the tobacco was pasted on to the glass receiver. Several leaves were rolled in the same manner and then allowed to dry in the air overnight. They were then oven-dried at 40°C. for 2 hours, after which they

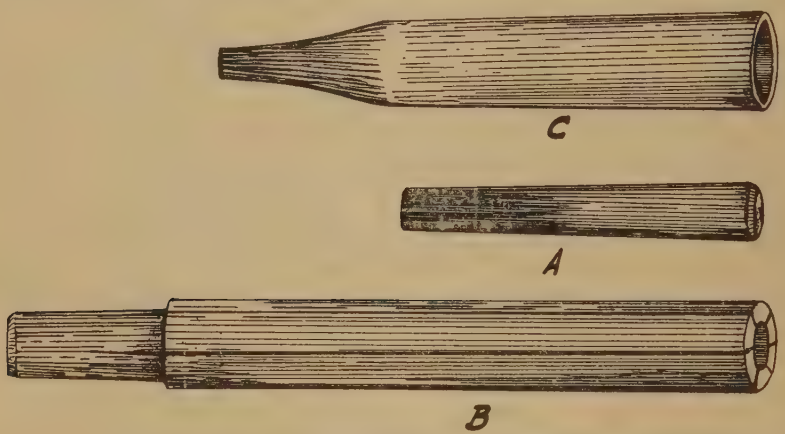


FIG. 1. Form for rolling the wrapper: *C*—glass adapter; *B*—cylinder; A—plug for *B*.

were ready for the test. The plug in the form was removed, causing the end of the form to collapse, and by careful manipulation the wooden form was removed, leaving the wrapper attached to one end of the glass adapter in the same form as it would have on a cigar. The wrapper was cut evenly, 9 cm. away from the glass. The glass adapter with the formed wrapper attached was fitted by means of its cork to the rest of the apparatus. The pump was so regulated that the discharge was 2 liters per minute, producing a slow suction through the whole apparatus. The wrapper was lighted by means of a flat flame. With the aid of a certified stop watch, the actual duration of time from the moment of lighting to the instant the glow was extinguished was taken.

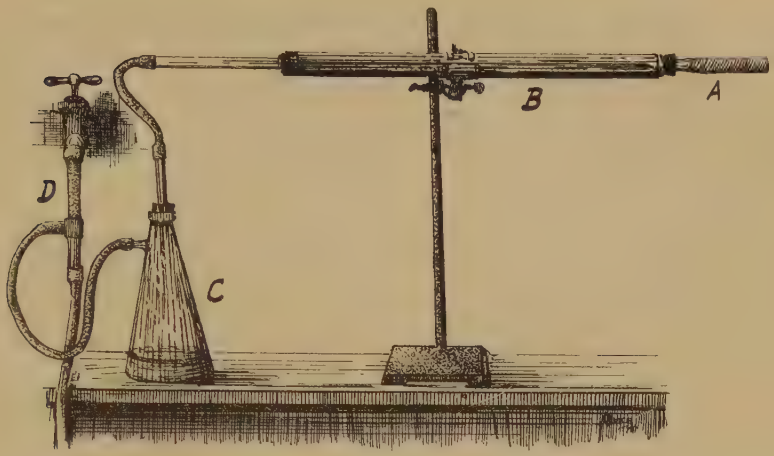


FIG. 2. Apparatus for testing the fire-holding capacity of wrappers: *A*—Wrapper in place; *B*—Smoke tube; *C*—Suction flask; *D*—Suction pump.

RESULTS AND DISCUSSION OF RESULTS

The results of these studies are compiled in Table 1. The samples used were hybrids selected by Mr. M. E. Gutierrez of the Breau of Plant Industry. From the wrapper leaves selected as many wrapper forms were made as to give the number of tests shown on the table. As stated above, the wrappers were cut exactly 9 cm. from the mouth of the glass adapter. As also stated, the duration of burn indicates the number of minutes registered by a stop watch from the time of lighting to the time the glow was extinguished. The area consumed per minute was taken as the quotient of the length consumed divided by the duration of burn. Since all the wrapper forms were made identical, the circumference of each corresponding section of any two wrappers should be equal. If this circumference be taken as unity, then this value multiplied by the quotient of the length consumed divided by the duration of burn will represent identical functions of the area, which may be considered equivalent to the area consumed per minute. The probable errors of the length consumed and of the duration of burn were computed by the standard formula. The probable error of the area consumed per minute was determined by considering the probable errors of the maximum and minimum values of the length consumed and the duration of burn.

Table 1 shows that of the 25 samples treated, Sample 5 burned the least with only 2.62 $\pm$ 1.46 cm. consumed. The duration of

burn of this sample was also shortest, being 1.86 ± 0.61 minutes. Sample 10 burned completely, with a duration of burn of 2.90 ± 0.13 minutes. The length consumed in Sample 1 was 8.97 ± 0.02, that in Sample 20 was 8.96 ± 0.03, and in Sample 21, 8.93 ± 0.04. Sample 5, with a length of 2.62 ± 1.46 cm. consumed, Sample 12 with 2.89 ± 0.55 cm., and Sample 6 at 3.37 ± 0.83 cm., burned least.

The longest duration of burn was in sample 1, which was 5.42 ± 0.23 minutes; in Sample 9, with 5.37 ± 0.44; and in

TABLE 1.—*Tests with the fire holding capacity of some Philippine wrappers*

Sample	Number of tests	Length of rolled wrapper	Length consumed	Duration of burn	Area consumed per minute
		cm.	*cm.*	*Min.*	*1×cm.*
1	8	9.0	8.97±0.02	5.42±0.23	1.65±0.14
2	8	9.0	8.64±0.25	2.44±0.11	3.54±0.23
3	7	9.0	8.21±0.19	2.91±0.09	2.82±0.09
4	9	9.0	8.15±0.55	4.40±0.48	1.85±0.37
5	5	9.0	2.62±1.46	1.86±0.61	1.41±1.85
6	9	9.0	3.37±0.83	2.21±0.40	1.52±0.80
7	8	9.0	6.61±0.71	4.25±0.27	1.56±0.28
8	8	9.0	8.70±0.08	3.87±0.14	2.25±0.10
9	8	9.0	8.23±0.51	5.37±0.44	1.67±0.26
10	8	9.0	9.00	2.90±0.13	3.10±0.15
11	8	9.0	7.08±0.44	3.47±0.21	2.04±0.26
12	9	9.0	2.89±0.55	3.04±0.38	0.95±0.34
13	7	9.0	5.81±0.90	3.01±0.20	1.93±0.46
14	7	9.0	4.48+0.99	3.23±0.66	1.39±0.74
15	6	9.0	7.71±0.94	5.07±0.67	1.52±0.45
16	8	9.0	6.47±0.50	4.04±0.34	1.60±0.28
17	9	9.0	8.64±0.15	3.35±0.22	2.58±0.22
18	9	9.0	8.21±0.50	2.82±0.13	2.91±0.33
19	8	9.0	7.55±0.70	4.07±0.26	1.86±0.30
20	7	9.0	8.96±0.03	2.36±0.10	3.80±0.18
21	6	9.0	8.93±0.04	2.64±0.08	3.38±0.10
22	7	9.0	8.04±0.58	2.81±0.15	2.86±0.38
23	9	9.0	7.93±0.54	3.03±0.19	2.62±0.30
24	7	9.0	7.21±0.33	2.85±0.13	2.53±0.25
25	9	9.0	8.07±0.55	3.59±0.14	2.25±0.25

Sample 15, with 5.07 ± 0.67 minutes. Sample 5 burned the shortest time, 1.86 ±0.61 minutes.

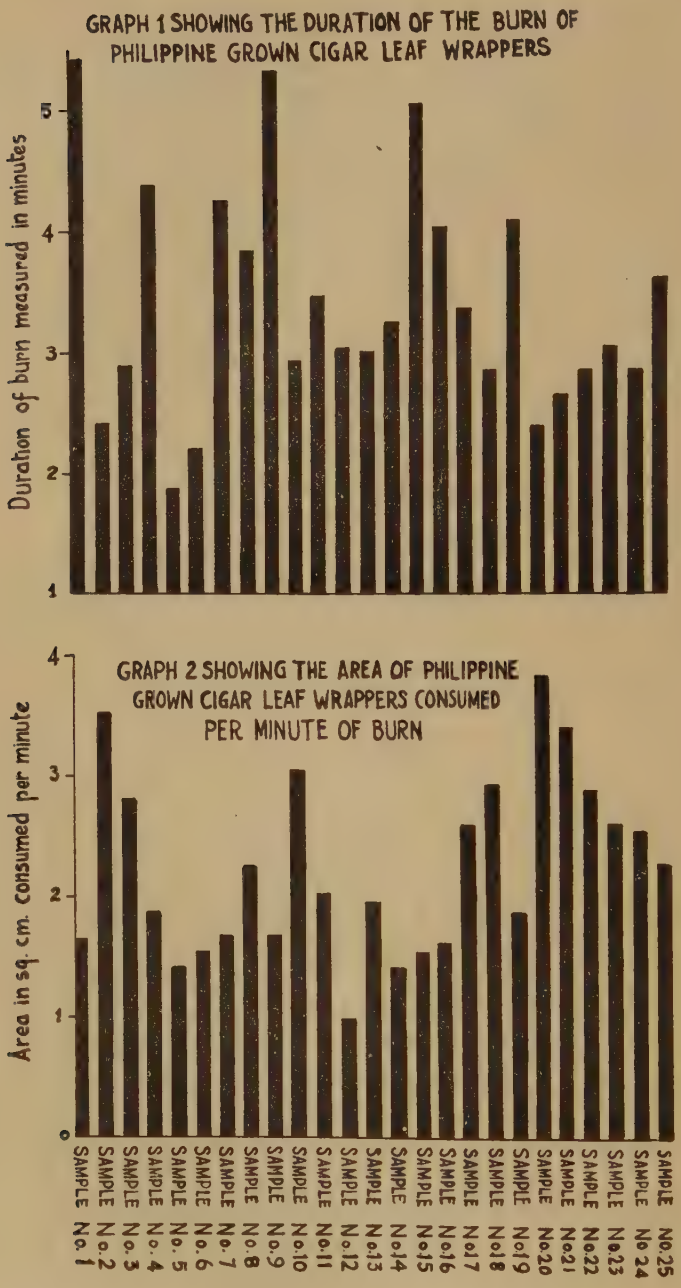
Sample 20 with 3.80 ± 0.18 square units consumed per minute, Sample 2 with 3.54 ± 0.23, Sample 21 with 3.38 ± 0.10 and Sample 10 with 3.10 ± 0.15 showed the greatest area consumed per minute. The area consumed per minute in Sample 12 was 0.95 ± 0.34; in Sample 14, 1.39 ± 0.74; and in Sample 7, 1.56 ± 0.28.

As stated above, the test reported in this paper takes consideration more of the area consumed per minute than of any other factor. Table 1 gives the area consumed per minute for the different samples, the value of each of them may be compared with one another. The least area consumed per minute was 0.95 ± 0.34, which apparently indicates a very slow burning wrapper. The observed cause for this slow burning was the mode of burning of the wrapper. A glow appeared like a streamer, going in a circular way around the wrapper form and giving the appearance that at each moment only one point in the wrapper was burning. This method of burning accounted for the uneveness of the burn and would not be desirable for a wrapper.

For a wrapper that was fast burning there is Sample 20 in which the area consumed per minute was 3.80 ± 0.18 with a relatively even burn.

Graphs 1 and 2 show the results graphically. From these it is apparent that Samples 12, 14, 5, 6, 16, 1, 7 and 9 are slow burning, while Samples 20, 2, 21 and 10 are fast burning. It may also be seen in these graphs that the area consumed per minute appears to be a better indication of the fire-holding capacity.

The above tests also indicate that the method of testing cigar wrappers reported in this study may be made use of, especially when comparative tests are conducted on wrappers subjected to the same conditions of selection and treatment. In the data presented for example, the probable error shows the evenness of reaction to the tests. Considering for example only the area consumed per minute, the probable error is, for many samples, not more than 0.30 which, in these cases, is below $\frac{1}{5}$ of the values. A high probable error would of course indicate undesirability of the wrapper tested. Basing on this consideration, we might state that on the whole, the test presented in this paper may be applied usefully to testing wrappers, provided the ordinary precautions as regards sampling and uniformity of treatment are followed. It is recognized that the value of wrapper also depends to a great extent upon the filler and binder used with it. However, it is essential that the quality of a wrapper should also be tested and that a method of accurate presentation of its inherent qualities be devised. The work presented in this paper was an attempt to accomplish this purpose.


GRAPH 1 SHOWING THE DURATION OF THE BURN OF PHILIPPINE GROWN CIGAR LEAF WRAPPERS
Duration of burn measured in minutes
1
2
3
4
5
GRAPH 2 SHOWING THE AREA OF PHILIPPINE GROWN CIGAR LEAF WRAPPERS CONSUMED PER MINUTE OF BURN
Area in sq. cm. consumed per minute
0
1
2
3
4
SAMPLE No. 1
SAMPLE No. 2
SAMPLE No. 3
SAMPLE No. 4
SAMPLE No. 5
SAMPLE No. 6
SAMPLE No. 7
SAMPLE No. 8
SAMPLE No. 9
SAMPLE No. 10
SAMPLE No. 11
SAMPLE No. 12
SAMPLE No. 13
SAMPLE No. 14
SAMPLE No. 15
SAMPLE No. 16
SAMPLE No. 17
SAMPLE No. 18
SAMPLE No. 19
SAMPLE No. 20
SAMPLE No. 21
SAMPLE No. 22
SAMPLE No. 23
SAMPLE No. 24
SAMPLE No. 25

SUMMARY

1. Twenty-five samples of Philippine-grown cigar wrappers were tested for fire-holding capacity.

2. The duration of burn was longest in Samples 1, 9, and 15. This was due to a peculiar mode of burning wherein a single glowing point burned in a circular way around the wrapper like a streamer. The duration of burn was shortest in Sample 5.

3. Sample 5 was consumed the least. Sample 10 burned completely. Samples 1, 20, and 21 were almost totally consumed.

4. Using the area consumed per minute as criterion, Samples 12, 14, and 5 were slow burning wrappers.

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GARNER, W. W. Methods of testing the burning quality of cigar tobacco. U. S. Dept. of Agr. Bull. 100 (1906): 31–40.

ILLUSTRATIONS

PLATE 1

Apparatus for testing the fire-holding capacity of wrappers.

TEXT FIGURES

FIG. 1. Form for rolling the wrapper. C, glass adapter; B, cylinder; A, plug for B.

2. Apparatus for testing the fire-holding capacity of wrappers. A, wrapper in place; B, smoke tube; C, suction flask; and D, suction pump.

GRAPH 1. Showing the duration of the burn of Philippine grown cigar leaf wrappers.

GRAPH 2. Showing the area of Philippine grown cigar leaf wrappers consumed per minute of burn.

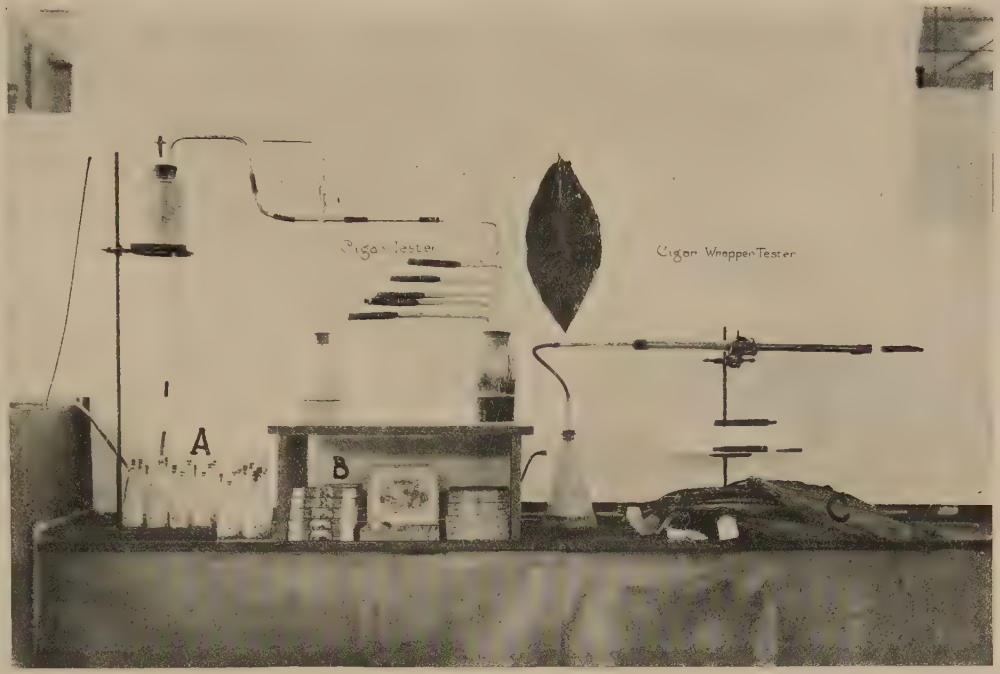

PLATE 1.

A NEW THRIPS ON COTTON[1]

By DUDLEY MOULTON[2]

The present paper records the finding of a new thrips which is a pest on cotton and other plants in the vicinity of Manila. The collections were made by Mr. F. Q. Otanes and were forwarded to me for identification by Mr. Jose S. Camus, Director of Plant Industry of the Department of Agriculture and Commerce. The new genus to which this species belongs is named *Bussothrips* from the Greek word "bussos" which means cotton or linen. I take pleasure in acknowledging the courtesy of Mr. Camus for forwarding these specimens to me for identification.

Genus BUSSOTHRIPS Moulton, 1935

(Family **THRIPIDAE** Uzel, Subfamily HELIOTHRIPINAE Karny.)

Reticulation of body distinct only on first seven abdominal segments. Head wider than long; eyes large occupying fully half the length of the head, ocelli approximate. Maxillary palpus with two segments. Antenna with eight segments, three four and six long and slender, three clearly constricted at both ends; style thripoid rather than heliothripoid in shade. Interocellar spines long, prominent. Prothorax wider than long; without marking; spines on anterior margin and a pair at each posterior angle long, prominent. Hind coxae approximate. Wings long, slender, only normally enlarged at base; with pointed tips; fore wing with ring vein complete, fore longitudinal vein united with costa at basal third, hind vein distinct; costal spines and fringe well developed; fore vein with six scattered spines in basal half, three in distal half, hind vein with three scattered spines in distal half.

Male with a part of thorns seated on long tubercles, on ninth abdominal segment and with two upwardly curved rods at tip.

BUSSOTHRIPS CLARATIBIA Moulton, new species.

Female holotype.—Color head and thorax yellowish brown with orange pigment, abdomen blackish brown. Antennal segments

[1] Received for publication, October 1, 1935.

[2] Former Director of the State of California Department of Agriculture.

one and two concolorus with head, three, four, basal halves of five and six mostly clear yellow, but with a shading of brown, distal halves of five, six light brown as are also seven and eight. Legs with all femora dark brown joints lighter, all tibiae and tarsi yellow except fore tibiae which are shaded in basal half. Fore wings clear in first, middle and last fifths and with two distinct dark cross bands in second and fourths fifth; hind wings clear but with a dark median line which fades before the end. (In lighter specimens the abdomen is brown but darker toward the tip.)

Total body length 1.5 mm. Head length .13 mm., width .176 mm.; prothorax length .12 mm., width .22 mm., Antennal segments: length (width) II, 33 (26); III, 73 (16); IV, 56 (18); V, 50 (16); VI, 70 (16); VII, 16; VIII, 23; total 326 microns. Length of spines: interocellar 53, on anterior margin of pronotum 66, on anterior angle 26, pair at posterior angles 70–80 microns; on ninth abdominal segment 140, on tenth 126 microns.

Head clearly wider than long, with transverse anastimosing lines behind eyes; interocellar spines placed within the ocellar triangle; a series of six smaller spines circling posterior margin of each eye; mouthcone extending two-thirds over prosternum, maxillary palpus with two segments. Antenna more than two and one-half times longer than head; forked sense cones on segments three and four; segment three, 4.5 times longer than greatest width, segment six almost equally as long; segments three and four constricted long and necklike at distal ends.

Prothorax without markings except two or three incomplete lines near posterior margin at sides; spines on anterior angles short, those on anterior margin about two and one-half times longer; pair at posterior angles longest; inward from these, only two extremely small spines along posterior margin. Character of wings as given in generic description. Legs slender, without armature. Comb on eighth abdominal segment complete.

Male allotype.—Colored as in female, somewhat smaller; armed at tip as given in generic description.

Type material.—Female holotype, male allotype, twenty-one female and two male paratypes taken on cotton October 29, 1934, by F. Q. Otanes and Jose S. Camus. Moulton No. 5301. Types in author's collection.

Type locality.—Singalong, Manila, Philippine Islands.

This genus and species belongs in the Family *Thripidae* Uzel but its placement in a subfamily is more difficult. The structure

of the wings excludes it from the subfamily *Thripinae* Karny, although its other body characters resemble those of a *Taeniothrips* Serville. The lack of microscopic pubescence on the abdomen and strongly developed spines on the thorax would seem to exclude it from the subfamily *Sericothripinae* Karny. I am therefore placing it in the subfamily *Heliothripinae* Karny, and near the genus *Hercothrips* Hood, from which it is easily distinguished by the shape of the antennal segments, lack of reticulation on head and thorax and the strongly developed postoculars and other spines an prothorax.

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A PRELIMINARY STUDY ON THE BURNING QUALITY OF CIGARS PREPARED WITH NATIVE AND IMPORTED WRAPPERS

By SALVADOR B. OLIVEROS, C. G. RAMOS and D. B. PAGUIRIGAN
Of the Bureau of Plant Industry

ONE TEXT FIGURE

INTRODUCTION

The annual average of Philippine exports of leaf tobacco for a period of 5 years, from 1928 to 1932, amounted to 6½ million pesos, while the annual average imports of the same commodity for the same period was nearly one million pesos. It is interesting to note that while the exported leaf tobacco commanded a price of ₱0.31 per kilo, the imported brand had a price of ₱2.67 per kilo. The explanation for this contrast is not hard to surmise. Although no itemized data on Philippine trade in tobacco is obtainable, it is obvious that as regards leaf tobacco trade, the Philippines can only export cigar fillers, since this type of tobacco is locally produced in abundance. Cigar fillers are the lowest-priced tobacco leaf. On the other hand, it is also obvious that the Philippines must import only aromatic cigarette filler and cigar wrapper, the costliest type of tobacco leaf in the market, inasmuch as, especially in the case of the former, the country does not yet produce sufficient quantities to meet the local demand.

A considerable portion of Philippine leaf tobacco imports consists of aromatic cigarette tobacco because of the increasing local manufacture of American style cigarettes. According to the local office of the American Trade Commissioner, the average yearly importation of aromatic cigarette tobacco into the Philippines for the years 1930, 1931 and 1932 amounted to ₱178,455 and of leaf tobacco, ₱782,963, thus leaving a probable average annual importation of cigar wrapper leaf tobacco amounting to about ₱600,000.

While Philippine imports of cigar wrappers have considerably decreased, from former values of about ₱2,000,000 to about ₱1,000,000 annual averages, as shown in Table 1, it is quite ob-

vious and economically sound that the Philippines should strive to produce more cigar wrappers not only to be self-sufficient in this commodity but also to be able to supply part of the cigar wrapper imports of the United States of which a portion coming from the Dutch East Indies was valued from ₱6,000,000 to ₱39,000,000 during the period from 1929 to 1932.

In the production of the types of tobacco to meet both the local and foreign markets, constant and continuous effort is being made by the Government and by a few courageous individuals and commercial firms. Success so far attained has partly been due to adoption of many foreign methods and partly through research to lower the cost of production, a factor that has served as a stumbling block to widespread culture. Although Paguirigan (1927), says that the best native grown wrappers are

TABLE 1.—*Cigar and tobacco leaf wrappers trade of the Philippines from 1929 to 1932*

Year	Cigars		Tobacco leaf wrappers			
	Exported		Exported		Imported	
	Quantity Number	Value Pesos	Quantity Kilos	Value Pesos	Quantity Kilos	Value Pesos
1928	220,884,441	9,530,279	20,217,486	6,059,265	370,158	1,838,609
1929	188,333,006	7,649,297	27,578,991	8,784,870	229,321	1,180,893
1930	178,560,744	7,090,446	20,770,616	7,451,758	186,916	851,467
1931	183,873,661	6,790,674	22,653,099	7,002,991	358,217	682,089
1932	182,574,853	6,462,436	21,620,470	5,644,466	848,354	815,334

comparable, in general appearance, to the imported product, and that there are possibly just as many brands and shapes of high-priced cigars wrapped with the native product as with the imported, still there is plenty of room for improving the locally-grown cigar leaf wrappers.

The never-ending experiments in breeding and selection in this country to produce the types of tobacco that could compete with those in the open market require methods of testing to show even slight differences in the particular quality or qualities desired. When a cigar tobacco is judged for its different qualities due regard must be given to each of the 3 components—the filler, the binder, and the wrapper—each of which has certain characteristics. The filler must have a fine flavor, aroma and a good burn. The wrapper, among its many properties, must possess a desirable color, shape and size; must be free from

any objectionable taste; must have sufficient elasticity to be worked conveniently; must have fine veins; and most important of all, must have a good burn. The last mentioned quality is of great importance for any tobacco crop. There have been several instances when crops of tobacco which have practically all the qualities to be desired were found useless because they would not burn. The burning quality of a cigar is not so simple as it appears to be. There are several elements which enter to make a good burn; namely, the capacity for holding fire, the evenness of the burn, coaling, "puckering"or the shrinking of the leaves immediately before the burning area, the firmness of the burn, and the rate of burning.

In the present work an attempt was made to convert all these qualities into linear measurements. Among the different qualities of a good burn, those that are easiest to detect are the evenness of the burn and the character of the ash. Garner (1907) found in his experiments that due consideration should be given to the proper balancing of the components of the cigar; that is, a heavy filler should be wrapped with a comparatively heavy wrapper, while a light-bodied filler requires a light bodied wrapper. With regards to the character of the ash, he is of the opinion that the influence of the wrapper and the binder is shown most strongly by the character of the ash, and that the binder materially influences the ash of the wrapper in this respect.

OBJECT OF THE PRESENT WORK

In the local trade in cigar leaf wrappers, the dealers in native wrappers and the importers of foreign wrappers claim, without any attempt to support such claim with scientific data, that their respective wrappers are better than the others. Without prejudice against any dealer's product, the present work has for its object the comparison of the burning qualities of native with imported cigar leaf wrappers with respect to the different elements that make a good burn.

MATERIALS AND METHODS

The cigars used were specially prepared for this experiment. The cigars having the same brand were made as closely uniform to each other as possible. The filler and binder used for each brand were the same in all cases. The cigars were specially ordered from a single cigar maker. For each brand having the same filler and binder five different wrappers were used; name-

ly, Isabela-grown and La Union-grown Vizcaya, which is a native wrapper; imported Sumatra, and Puerto Rico-grown and Georgia-grown Havanensis wrappers. The cigars were smoked by an appropriate apparatus in order to eliminate any personal equation.

The apparatus shown in Figure 1 may be briefly described as follows: The "mouths" or pipes *a, b, c, d* and *e,* were of exactly equal lengths. Five pipes were used in order to subject the five differently wrapped cigars under the same conditions of smoking.

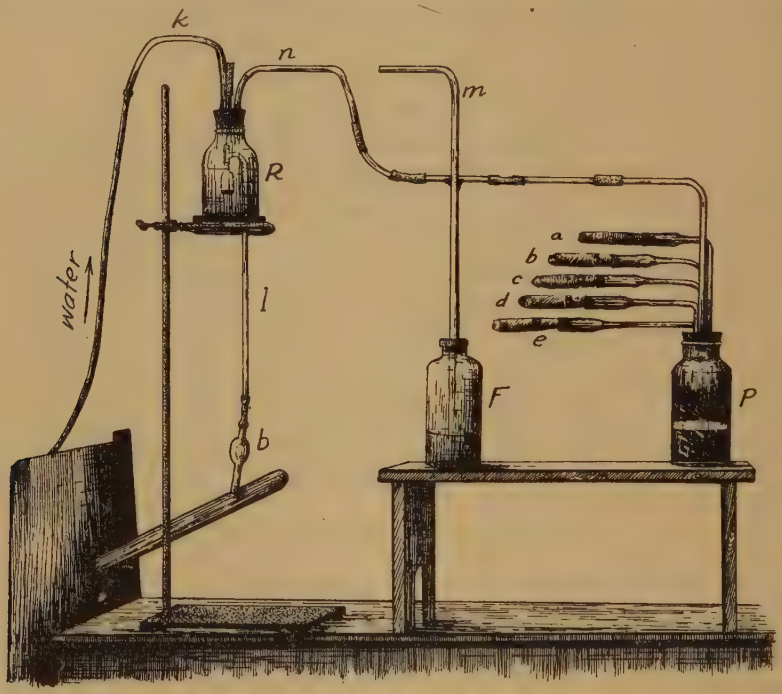

FIG. 1. Mechanical cigar smoker.

Between the flask *P* holding the mouth-end of the pipes and the aspirator *R* was another flask *F* with a two hole-rubber stopper. Through one of the holes was inserted a check valve consisting of a T-tube the lower arm of which reached beneath the surface of the water in the flask *F*. This arrangement was to prevent a backward pressure while the aspirator was filling. Through the other hole and flush with the inner surface of the stopper of flask *F* was passed another glass tubing *m* for carrying out the obnoxious fumes. The aspirator *R* consisted of a mason jar provided with a two-hole rubber stopper. Through one of

the holes was inserted a tube *n*, leading to the flask containing the pipes and through the other hole, another tube *k* supplying water from the faucet. A hole was made at the base of the mason jar and the long arm *l* of the siphon was inserted.

The long arm *l* was 58.6 cm. with an inner diameter of 9 mm. The discharge end of this long arm of the siphon was provided with a bulb *b* for helping break the flow of water at the moment the aspirator was emptied. The short arm of the siphon was 11 cm. long with an inner diameter of 3 mm. for 6 cm. of its length, the rest being tapered to the size of the connecting glass tubing. The operation of the aspirator was timed with a stop-watch so that it would fill in 30 seconds and empty in 10 seconds. The actual time of suction was therefore 10 seconds for every 40 seconds.

The close end of the cigar was cut in the ordinary way of cutting cigars for smoking. For each brand 5 cigars with different wrapers were tightly placed in the pipes. There were ten tests with each brand, so that each of the 5 cigars of the same wrapper occupied each of the five pipes two times.

In the case of cigars in which the open end consisted of the entire cross-sectional area of the cigar, lighting was done by applying a low flame on the open end during a suction period. When the aspirator began to empty again the flame was applied on the cigar in the next pipe and so on until all the cigars were lighted. The time was taken at the instance of the first lighting. After the cigars have burned to a reasonable length the color of the ash was taken by comparing its color with a suitable color standard (Ridgway, 1912). The lengths of the points in the burnt cigar farthest and nearest the mouth were measured as soon as the ash first fell, and also at the termination of the smoking period. The average length of the cigar when the ash fell was subtracted from the initial length of the cigar and the difference recorded as firmness of ash. The average at the termination of smoking period was subtracted from the initial length, and the difference was taken as length consumed. The minimum and maximum width of coaling were also measured; the average of the two was termed coaling. The shrinking of the wrappers immediately before the burning area was noted. The other observations made were the number of lightings to start the burning of the cigar and the duration of burn when a cigar stopped burning before the time limit.

RESULTS AND DISCUSSION OF RESULTS

The wrappers used in the study were Vizcaya wrapper grown in Isabela and termed Isabela; Vizcaya wrapper grown in La Union and termed La Union; Havanensis wrapper from Georgia, termed Georgia, Havanensis wrapper from Puerto Rico, termed Puerto Rico, and imported Sumatra wrapper.

The observations and measurements obtained from mechanically smoking the 700 cigars used in these studies were too voluminous, and it was deemed wise not to include the complete experimental data in this report. Table 2, giving sample sheets from the laboratory notebooks, however, shows how the experimental data were gathered. The measurements indicated were taken by means of a pair of dividers and an accurately graduated millimeter scale. In Table 2 is given the length of cigar at the beginning of the test; the maximum, minimum and average lengths of the cigar after smoking; the length consumed, which was taken as the difference between the length of the cigar at the beginning of the test and the average length after smoking; and the length of the cigar when the ash first fell. This last measurement was subtracted from the initial length of the cigar to get the length of the first ash, which was taken as the firmness of ash. The difference between the maximum and minimum lengths of the cigar after smoking is given as the evenness of burn. The time limit for all smoking was 30 minutes, and cigars ceasing to burn before the time limit were duly recorded. The number of lightings indicates how many times a lighted match-stick had to be applied to the open end of the cigar before the said cigar commenced to burn. The color of the ash was determined by comparison with standard color tables, and at the end of a set of experiments the ash of the differently wrapped cigars were compared one with another to find which ash was darkest and which was whitest. The whitest ash was indicated as 1 and the darkest as 5.

Four of the measureable qualities obtained in Table 2 were subjected to statistical treatment. Table 3 shows the averages, with probable errors, of ten samples for the evenness of burn, firmness of ash, coaling and length consumed, for each wrapper for each brand. The formula used for the probable error of the average was $P.E. = \pm 0.6745 \sqrt{\frac{\Sigma v^2}{n(n-1)}}$ where $P.E.$ is the probable error, Σv^2 is the sum of the squares of the differences of the actual values from the average, and n is the number of

TABLE 2.—*Sample sheets from laboratory notebook on smoking tests*

Set No.	Wrapper	Length of cigar						Time of smoking	Length of first ash	Evenness of burn	Number of lightings	Coaling			Color of ash		"Puckering"
		At beginning of test	After smoking			Consumed	When ash first fell					Maximum	Minimum	Average	Actual	Rank in test 1st=1; 5th=5	
			Maximum	Minimum	Average												
		cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*	*min.*	*cm.*	*cm.*		*cm.*	*cm.*	*cm.*			
1	LU-1	13.9	9.8	8.8	9.3	4.6	8.8	30	5.1	1.0	1	0.3	0.1	0.2	Pallid purplish gray	5	Very slight.
	S-2	13.9	3.3	2.6	3.0	10.9	5.1	30	8.8	0.7	1	0.2	0.1	0.2	Pale dull gray	1	Slight.
	G-3	13.9	6.1	5.6	6.9	8.0	7.4	30	6.5	0.5	2	0.3	0.1	0.2	Pallid purplish gray	2	Very slight.
	PR-4	13.9	6.4	5.8	6.1	7.8	7.6	30	6.3	0.6	1	0.3	0.1	0.2	Pale neutral gray	4	Slight.
	I-5	13.9	5.6	5.2	5.4	8.5	7.8	30	6.1	0.4	1	0.2	0.1	0.2	Pallid neutral gray	3	Very slight.
3	PR-1	13.9	4.2	3.9	4.1	9.8	7.8	30	6.1	0.3	1	0.2	0.1	0.2	Pallid neutral gray	5	Very slight.
	I-2	13.9	4.8	4.1	4.5	9.4	6.6	30	7.3	0.6	1	0.4	0.1	0.3	French gray	3	Slight.
	LU-3	13.9	5.7	5.3	5.5	8.4	7.4	30	6.5	0.3	1	0.2	0.1	0.2	Pallid neutral gray	4	Slight.
	S-4	13.9	6.3	5.8	6.1	7.8	8.2	30	5.7	0.5	1	0.3	0.1	0.2	Pale dull gray	1	Slight.
	G-5	13.9	6.3	6.1	6.2	7.5	8.2	30	5.7	0.2	1	0.3	0.2	0.3	Pallid purplish gray	2	Slight.
9	G-1	13.9	4.0	3.6	3.8	10.1	7.4	30	6.3	0.4	1	0.3	0.1	0.2	Pallid purplish gray	2	Very slight.
	PR-2	13.9	4.5	3.9	4.2	9.7	7.8	30	6.0	0.6	1	0.3	0.1	0.2	Pale neutral gray	4	Very slight.
	I-3	13.9	5.1	4.5	4.8	9.1	8.2	30	5.7	0.6	1	0.2	0.1	0.2	Light dull gray	5	Slight.
	LU-4	13.9	8.0	7.5	7.8	6.1	7.5	30	6.4	0.5	1	0.3	0.1	0.2	Pale dull gray	3	Slight.
	S-5	13.9	4.8	3.4	4.1	9.8	7.6	30	6.3	1.4	1	0.4	0.1	0.3	Light dull gray	1	Slight.

TABLE 3.—*Measurement of four smoking qualities of cigars*

Brand and wrapper	Evenness of burn	Firmness of ash	Coaling	Length of cigar consumed in 30 min.
Brevas:				
Georgia	0.89±0.14	6.13±0.26	2.15±0.22	7.57±0.38
Isabela	0.83±0.10	5.80±0.26	2.29±0.17	5.92±0.36
La Union	0.72±0.09	6.06±0.12	1.97±0.23	6.47±0.21
Porto Rico	1.13±0.15	6.20±0.50	2.33±0.18	6.78±0.66
Sumatra	0.63±0.07	5.90±0.44	1.83±0.11	6.75±0.50
Cazadores:				
Georgia	0.77±0.03	5.62±0.20	2.22±0.17	7.44±0.37
Isabela	0.77±0.12	5.64±0.15	1.78±0.12	6.73±0.49
La Union	0.62±0.06	5.49±0.21	1.90±0.11	6.70±0.36
Porto Rico	0.61±0.06	5.05±0.22	2.38±0.23	5.83±0.41
Sumatra	0.85±0.12	5.98±0.34	2.31±0.22	7.92±0.38
Conchas:				
Georgia	0.62±0.06	6.62±0.25	1.92±0.11	6.78±0.32
Isabela	0.46±0.06	5.65±0.24	1.61±0.07	6.54±0.43
La Union	0.52±0.05	5.50±0.13	1.87±0.08	5.61±0.18
Porto Rico	0.73±0.07	6.20±0.16	1.88±0.04	6.33±0.19
Sumatra	0.60±0.06	5.71±0.28	1.82±0.09	6.01±0.34
Exquisitos:				
Georgia	0.58±0.09	6.45±0.17	1.80±0.11	6.70±0.19
Isabela	0.60±0.04	6.33±0.15	1.70±0.05	6.77±0.16
La Union	0.55±0.07	6.28±0.13	1.94±0.13	7.21±0.27
Porto Rico	0.59±0.04	6.47±0.17	1.65±0.08	8.30±0.40
Sumatra	0.74±0.14	6.76±0.24	2.16±0.23	7.17±0.23
Favoritos de Carrion:				
Georgia	0.74±0.05	6.02±0.20	2.24±0.11	7.84±0.30
Isabela	0.65±0.07	6.90±0.24	2.30±0.19	8.01±0.32
La Union	0.80±0.12	6.50±0.25	1.92±0.12	8.36±0.19
Porto Rico	0.47±0.06	5.74±0.42	1.97±0.18	8.27±0.34
Sumatra	0.40±0.04	6.16±0.22	1.87±0.06	8.03±0.30
High life:				
Georgia	0.85±0.07	6.00±0.20	1.99±0.14	6.11±0.35
Isabela	0.47±0.03	6.40±0.16	1.66±0.07	6.85±0.19
La Union	0.59±0.03	6.20±0.29	1.60±0.09	6.40±0.27
Porto Rico	0.71±0.08	6.43±0.18	2.00±0.13	6.96±0.38
Sumatra	0.62±0.08	5.93±0.32	1.88±0.10	6.52±0.33
Imperiales:				
Georgia	0.52±0.06	6.05±0.12	2.57±0.19	8.16±0.26
Isabela	0.66±0.06	6.47±0.15	2.07±0.18	8.30±0.18
La Union	0.65±0.11	6.12±0.17	2.16±0.09	7.96±0.42
Porto Rico	0.50±0.05	6.17±0.07	2.09±0.11	8.01±0.31
Sumatra	0.61±0.06	6.21±0.21	2.07±0.09	8.30±0.30
Londres:				
Georgia	0.57±0.05	5.28±0.21	2.00±0.10	7.44±0.35
Isabela	0.41±0.02	5.06±0.34	1.72±0.11	6.40±0.32
La Union	0.66±0.11	5.64±0.40	2.07±0.13	7.35±0.27
Porto Rico	0.37±0.06	5.19±0.20	1.90±0.12	5.79±0.09
Sumatra	0.62±0.11	5.20±0.16	1.87±0.10	7.12±0.24
Media Regalia:				
Georgia	0.62±0.09	5.81±0.27	2.90±0.19	7.52±0.35
Isabela	0.60±0.03	5.85±0.20	1.73±0.07	6.18±0.25
La Union	0.74±0.08	6.20±0.23	2.10±0.10	6.80±0.20
Porto Rico	0.65±0.06	5.91±0.21	1.99±0.05	6.63±0.28
Sumatra	0.60±0.07	5.55±0.11	1.99±0.09	6.60±0.20

TABLE 3.—*Measurement of four smoking qualities of cigars*—Continued.

Brand and wrapper	Evenness of burns	Firmness of ash	Coaling	Length of cigar consumed in 30 min.
Monterrey:				
Georgia	1.09±0.13	4.79±0.30	2.88±0.18	5.53±0.64
Isabela	1.12±0.15	5.45±0.53	2.62±0.16	5.07±0.47
La Union	1.34±0.11	4.75±0.32	2.68±0.23	6.43±0.55
Porto Rico	0.75±0.12	4.99±0.28	2.32±0.15	6.86±0.59
Sumatra	0.93±0.10	5.53±0.30	2.22±0.15	6.29±0.45
Panetelas Imperiales:				
Georgia	0.89±0.18	5.02±0.19	2.61±0.19	7.12±0.49
Isabela	0.35±0.02	4.77±0.39	2.10±0.11	7.80±0.45
La Union	0.59±0.06	4.64±0.23	2.32±0.10	6.57±0.55
Porto Rico	0.47±0.07	5.43±0.30	2.00±0.08	8.14±0.37
Sumatra	0.44±0.06	4.64±0.24	2.00±0.14	8.34±0.64
Perfectos:				
Georgia	0.64±0.08	5.45±0.19	1.89±0.10	5.48±0.23
Isabela	0.59±0.08	5.48±0.28	1.90±0.20	5.69±0.39
La Union	0.62±0.06	5.67±0.18	1.78±0.09	5.40±0.21
Porto Rico	1.12±0.28	5.92±0.21	2.09±0.12	5.91±0.24
Sumatra	0.72±0.11	5.93±0.32	2.42±0.08	5.64±0.32
Regalia Imperial:				
Georgia	0.90±0.14	5.44±0.46	2.51±0.20	5.97±0.56
Isabela	0.54±0.03	5.84±0.27	2.16±0.15	6.79±0.35
La Union	0.82±0.08	5.85±0.44	2.32±0.20	6.48±0.55
Porto Rico	1.36±0.41	5.72±0.36	2.28±0.20	5.75±0.41
Sumatra	1.18±0.13	5.76±0.44	2.48±0.16	5.87±0.56
Regentes:				
Georgia	0.75±0.08	5.72±0.30	2.47±0.17	6.37±0.48
Isabela	0.74±0.09	5.99±0.29	1.97±0.08	6.84±0.38
La Union	0.56±0.05	5.60±0.24	2.26±0.19	6.42±0.31
Porto Rico	0.57±0.11	5.99±0.20	1.96±0.09	6.46±0.44
Sumatra	0.76±0.10	6.34±0.30	2.30±0.20	7.04±0.38

samples which in this case was 10. The wrappers in every brand were compared one with another, that is, for example, for the brand Brevas these comparisons were made: Georgia *vs.* Isabela; Georgia *vs.* La Union; Georgia *vs.* Puerto Rico; Georgia *vs.* Sumatra; Isabela *vs.* La Union; Isabela *vs.* Puerto Rico; Isabela *vs.* Sumatra; La Union *vs.* Puerto Rico; La Union *vs.* Sumatra; and Puerto Rico vs. Sumatra. The probable error of the difference between any two averages was computed using the formula: $P.E._{(A-B.)} = \sqrt{(P.E._A)^2 + (P.E._B)^2}$ that is the probable error of the difference between two averages is the square root of the sum of the squares of their probable errors. When the difference was 3 or more than 3 times the value of its probable error, the difference was significant. The results of

such comparisons, when the differences between any two measurements were significant, are given in Table 4. It will be noted that the differences that were significant were very few in comparison with the total number of measurements taken. Thus in evenness of burn only 10 out of 700 measurements or of 70 averages, gave significant differences; in firmness of ash only 2, in coaling only 7 and in length consumed only 8. The averages that gave significant differences were only 4.82 per cent of the total number of camparisons. It may then be inferred that in a general way, there was no difference at all between the wrappers as far as the 4 measurable qualities—evenness of burn, firmness of ash, coaling and length consumed—were concerned.

In Table 4 under evenness of burn, in the brand Favoritos de Carrion, Georgia, compared with Puerto Rico, gave a difference of 0.27 ± 0.08. As shown, Georgia had the higher measurement and Puerto Rico the lower value. In evenness of burn the higher measurement indicates inferiority, since the evenness of burn was taken as the difference between the maximum and minimum lengths of the cigar after burning, whereby a cigar burning very evenly would show no difference in measurements. The same table shows that the firmness of ash, in the brand Conchas, Georgia *vs.* La Union, showed difference of 1.12 ± 0.29, meaning that Georgia had a longer ash than La Union and therefore was better in this respect. Under length consumed, in the brand Brevas, Georgia gave a bigger measurement than Isabela by 1.65 ± 0.52, and since for the time limit, it was considered that the longer the portion of cigar consumed the better, Georgia showed a superiority over Isabela in this respect.

The number of instances that any wrapper showed superiority over or inferiority to another wrapper in Table 4 was recorded in Table 5. Under evenness, of burn, for example, in Table 5, for the wrapper Georgia, there was no instance in which it showed superiority over any other wrapper; but in four instances it was inferior to some other wrapper. By subtracting the instances of inferiority from the instances of superiority, a balance was obtained, either a positive or negative number, depending on how the wrapper behaved. In the example of Georgia the balance was —4. For the same quality the wrapper Isabela was superior to some other wrapper in 4 instances but inferior in 1 giving a balance of +3; La Union was superior in

TABLE 4.—*Differences in measurements of four smoking qualities of cigars*

Brand	Wrapper Higher numerical value *vs.* Lower numerical value	Difference
1. *Evenness of burn: Lower numerical value indicating superiority:*		
Favoritos de Carrion	Georgia *vs.* Porto Rico	0.27±0.08
	Georgia *vs.* Sumatra	0.34±0.07
	Isabela *vs.* Sumatra	0.25±0.08
	La Union *vs.* Sumatra	0.40±0.13
High Life	Georgia *vs.* Isabela	0.38±0.08
	Georgia *vs.* La Union	0.26±0.08
Monterrey	La Union *vs.* Porto Rico	0.59±0.17
Panetelas Imperiales	La Union *vs.* Isabela	0.24±0.07
Regalia Imperial	La Union *vs.* Isabela	0.28±0.09
	Sumatra *vs.* Isabela	0.64±0.13
2. *Firmness of ash: Higher numerical value indicating superiority:*		
Conchas	Georgia *vs.* La Union	1.12±0.29
	Porto Rico *vs.* La Union	0.70±0.20
3. *Coaling: Lower numerical value indicating superiority:*		
Conchas	Porto Rico *vs.* Isabela	0.27±0.08
Media Regalia	Georgia *vs.* Isabela	1.17±0.20
	Georgia *vs.* La Union	0.80±0.21
	Georgia *vs.* Porto Rico	0.91±0.19
	Georgia *vs.* Sumatra	0.91±0.21
Perfectos	Sumatra *vs.* Georgia	0.53±0.13
	Sumatra *vs.* La Union	0.64±0.12
4. *Length consumed: Higher numerical value indicating superiority:*		
Brevas	Georgia *vs.* Isabela	1.65±0.52
Cazadores	Sumatra *vs.* Porto Rico	2.09±0.56
Exquisitos	Porto Rico *vs.* Georgia	1.60±0.45
	Porto Rico *vs.* Isabela	1.53±0.43
Londres	Georgia *vs.* Porto Rico	1.65±0.36
	La Union *vs.* Porto Rico	1.56±0.27
	Sumatra *vs.* Porto Rico	1.33±0.26
Media Regalia	Georgia *vs.* Isabela	1.34±0.43

1 instance and inferior in 4, giving a balance of —3; Puerto Rico was superior in 2 instances and did not record any instance of inferiority, giving a balance of +2; and Sumatra was superior in 3 instances and inferior in one, giving a balance of +2. To give points arbitrarily to each wrapper, the lowest score indicated by the lowest arithmetical value was given no point. In the example taken Georgia scoring —4 was given zero, La Union scoring —3 was given 1 point, Puerto Rico and Sumatra both scoring +2 were given 6 points each, and Isabela scoring +3 was given 7 points. The score and the points awarded were on the same scale, only moved forward so that no negative value would be shown. The firmness of ash, coaling, and length

TABLE 5.—*Scores of wrappers for all brands for four smoking qualities*

Wrapper	Evenness of burn				Firmness of ash			
	Instances			Points awarded	Instances			Points awarded
	Superior	Inferior	Balance		Superior	Inferior	Balance	
Georgia	0	4	−4	0	1	0	+1	3
Isabela	4	1	+3	7	0	0	0	2
La Union	1	4	−3	1	0	2	−2	0
Porto Rico	2	0	+2	6	1	0	+1	3
Sumatra	3	1	+2	6	0	0	0	2

Wrapper	Coaling				Length consumed			
	Instances			Points awarded	Instances			Points awarded
	Superior	Inferior	Balance		Superior	Inferior	Balance	
Georgia	1	4	−3	0	3	1	+2	5
Isabela	2	0	+2	5	0	3	−3	0
La Union	2	0	+2	5	1	0	+1	4
Porto Rico	1	1	0	3	2	4	−2	1
Sumatra	1	2	−1	2	2	0	+2	5

consumed were treated likewise. This method of awarding points gave equal emphasis to the 4 qualities scored.

The color of ash is another quality very often used to judge cigars. Table 6 shows the score of each wrapper under each brand for the color of ash. In Table 2 for each set of tests the color of the ash of each cigar was compared with those of the others. The whitest ash was given a grade of 1 and the darkest ash was given a grade of 5. Table 6 shows the sum of the scores on color of ash. The wrapper showing the whitest ash with the most frequency for each brand naturally obtained the smallest total. Basing upon these totals the rank in the brand was noted. The smallest total was given 1 and the highest total was given 5, showing that the wrappers with the smallest total was the best wrapper as far as the color of the ash was concerned. Table 6 also gives the grand total for all brands and likewise the rank in the whole test showing that as far as the color of ash was concerned the rank was as follows: Sumatra, Isabela, Georgia, Puerto Rico and La Union. Awarding points in the same manner as described above, Georgia obtained 2 points; Isabela, 3; La Union, 0; Puerto Rico, 1; and Sumatra, 4.

TABLE 6.—*Color of ash*

Brand	Wrapper	Total points	Rank in brand
Brevas	Georgia	37	3
	Isabela	35	2
	La Union	28	1
	Porto Rico	28	1
	Sumatra	28	1
Cazadores	Georgia	21	2
	Isabela	35	3
	La Union	40	5
	Porto Rico	38	4
	Sumatra	16	1
Conchas	Georgia	24	2
	Isabela	25	3
	La Union	30	4
	Porto Rico	45	5
	Sumatra	21	1
Exquisitos	Georgia	19	1
	Isabela	29	3
	La Union	46	5
	Porto Rico	32	4
	Sumatra	28	2
Favoritos de Carrion	Georgia	34	4
	Isabela	29	3
	La Union	41	5
	Porto Rico	24	2
	Sumatra	22	1
High Life	Georgia	35	3
	Isabela	32	2
	La Union	38	4
	Porto Rico	35	3
	Sumatra	10	1
Imperiales	Georgia	23	2
	Isabela	34	4
	La Union	45	5
	Porto Rico	33	3
	Sumatra	15	1
Londres	Georgia	24	2
	Isabela	33	3
	La Union	41	5
	Porto Rico	36	4
	Sumatra	15	1
Media Regalia	Georgia	45	5
	Isabela	17	2
	La Union	38	4
	Porto Rico	35	3
	Sumatra	14	1
Monterrey	Georgia	25	1
	Isabela	27	2
	La Union	37	4
	Porto Rico	34	3
	Sumatra	25	1
Panetelas Imperial	Georgia	37	4
	Isabela	26	1
	La Union	34	3
	Porto Rico	27	2
	Sumatra	26	1

TABLE 6.—*Color of ash*—Continued.

Brand	Wrapper	Total points	Rank in brand
Perfectos	Georgia	26	2
	Isabela	22	1
	La Union	45	4
	Porto Rico	26	2
	Sumatra	28	3
Regalia Imperial	Georgia	26	2
	Isabela	25	1
	La Union	41	5
	Porto Rico	30	4
	Sumatra	27	3
Regentes	Georgia	32	4
	Isabela	23	1
	La Union	39	5
	Porto Rico	31	3
	Sumatra	25	2
For all brands			Rank in test
	Georgia	408	3
	Isabela	392	2
	La Union	543	5
	Porto Rico	454	4
	Sumatra	300	1

The number of lightings, that is, the number of times a lighted matchstick had to be applied to the free end of a cigar at the commencement of the smoking is another indication of the smoking quality of such a cigar. Actual counts in the test showed that the number of second re-lightings for each wrapper out of the 140 samples were; Georgia 5, Isabela 5, La Union 5, Puerto Rico 7 and Sumatra 6. As far as this quality was concerned therefore the wrappers were practically the same.

Another smoking quality looked for in cigars is invariably the continuity of burn; that is, for a given length of smoking, a smoker desires that he lights a cigar only once and that the cigar burns continuously to the stub. The mechanical smoker used in this test was particularly satisfactory for making observations in this respect, since most of the conditions that would be variable in a smoker's mouth were equalized or made constant. Actual count showed that the number of cigars that ceased to burn before the time limit, was by wrappers, as follows: Georgia 2, Isabela 4, La Union 2, Puerto Rico 2, Sumatra 3. Since there were 140 cigars smoked the differences shown above are negligibly small.

The sum of the points awarded each wrapper in Table 5 are as follows:

Georgia	8
Isabela	14
La Union	10
Puerto Rico	13
Sumatra	15

The differences between wrappers were not very marked, especially if it is remembered that 700 samples were tested.

It will also be remembered that the tests were made on the assumption that for each brand, filler and binder were as uniform as possible. Since the manipulations in the manufacture of these cigars preclude such a uniformity, differences in the behavior of the cigars under satisfactorily constant conditions of smoking must be considerable in order that correct judgment of the wrappers can be made. No such marked differences were found in these tests.

SUMMARY

1. Five wrappers were ordered used in making fourteen brands of cigars in such a manner that filler and binder for each brand were as uniform as possible for the brand. The wrappers used were: La Union-grown Vizcaya; Isabela-grown Vizcaya; Georgia-grown Havanensis; Puerto Rico-grown Havanensis and Sumatra-grown Sumatra. Ten cigars in each wrapper having the same brand were mechanically smoked in ten sets by a 5-mouthed smoking apparatus such that each mouth smoked a differently wrapped cigar in each set of tests. Linear measurements as indices of evenness of burn, firmness of ash, coaling and length consumed, were taken. Observations were made as to the number of lightings to start the burn, "puckering", cessation of burn prior to the time limit set, and color of ash, both actual and relative. The measurements gathered were subjected to statistical treatment to find significant differences.

2. Of 700 comparisons of average measurements for each quality, there were 10 significant differences in the evenness of burn, 2 in firmness of ash, 7 in coaling and 8 in the length consumed. It is apparent, therefore, that there was hardly any difference between any two differently wrapped cigars.

3. Sumatra wrapped cigars gave the greatest frequency, and the whitest ash; followed in turn by cigars wrapped in Isabela, Georgia, Puerto Rico and La Union wrappers.

4. Provided that the limitations necessarily attending the tests described are kept in mind, the method is believed satisfactory and of utility.

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ILLUSTRATION

TEXT FIGURE

FIG. 1. Mechanical cigar smoker.

QUARTERLY NOTES

NOTES ON MOTTLE-LEAF AND ANTHRACNOSE FRUIT SPOT OF CITRUS IN BUKIDNON [1]

By MACARIO A. PALO

Assistant Plant Pathologist Bureau of Plant Industry

TWO PLATES AND ONE TEXT FIGURE

Mottle-leaf.—This is the most serious disease of citrus in Bukidnon. Although it is non-infectious, because of its non-parasitic nature, the disease appears rather general in nearly all the citrus orchards in fourteen settlement farm schools in Bukidnon. The disease can be recognized readily by the absence of chlorophyll in certain parts of the leaves between the main lateral veins (Plate 1, fig. 1). Of the commercial varieties of citrus commonly grown in Bukidnon, those which show the disease so distinctly are the sweet orange (*Citrus sinensis* Osbeck), the pummelo (*Citrus maxima* [Burn.] Merrill), and the mandarin (*Citrus nobilis* Lour), in the order of their enumeration.

In serious cases of the disease defoliation takes place, after which the twigs die gradually beginning from the tips (Plate 1, fig. 2). Usually after a severe dying-back of the twigs, numerous shoots spring up on the trunk and primary branches; but in trees thriving in impoverished soil, mottling of the leaves reappears and afterward defoliation and dying-back of the twigs take place again. Soon the affected tree dies. This disease caused the death of several citrus trees in Bugcaon and Kalasungay settlement farms and rendered about 40 trees in Alanib and 600 trees in Lantapan less productive, commercially. The marked decline of the yield in fruits of citrus orchards in other settlement farms has been attributed primarily to this disease.

Mottle-leaf is a physiological disease, the exact cause or causes of which have not been definitely determined. It is believed that it is due to certain abnormal conditions of the soil.

[1] Mottle-leaf and anthracnose spot are among the common citrus diseases found in a survey of Bukidnon during the early part of 1935.

Some conditions of the soil which are said to be contributory causes of citrus mottle-leaf are deficiencies of certain elements, inadequate supply of nitrogen, excess of nitrogen, lack of humus, toxic minerals in soils, and organic soil toxins.

The control of citrus mottle-leaf is also curious. While soil conditions are believed to be directly related to it, still their adjustments often fail to restore the health of trees seriously affected with it. Recently, it was found in California that this disease can be controlled more or less successfully by spraying with zinc sulphate applied either singly or in combination with lime or lime-sulphur. The results obtained with zinc sulphate-lime sulphur and zinc sulphate-lime hydrate have been claimed astonishing; however, no explanation was given why the mottled and depauperate yellow leaves became living green in a few weeks. For the control of citrus mottle-leaf in California, the best so far observed by experiment was light spraying with zinc sulphate-lime hydrate which was recommended by Parker[2] as follows: "For severe mottling, a spray of 10 lbs. zinc sulphate (about 25 per cent zinc) and 5 pounds hydrated lime to 100 gallons of water. For slightly or moderately affected trees, a spray of 5 lbs. zinc sulphate and $2\frac{1}{2}$ pounds of hydrated lime to 100 gallons of water." To each of these spray mixtures should be added 4 ounces of powdered or liquid blood albumin as spreader before using.

For the control of citrus mottle-leaf in Bukidnon, the recommendations above should be tried with great caution under a wide variety of conditions. The treatment specified in the recommendation above should not be taken as a substitute for good fertilizer and general cultural practices. Since the soils in a number of citrus orchards, where mottle-leaf was general, have been found by chemical analysis to be highly acidic and deficient in calcium, potassium and phosphorous, the conditions of the trees may perhaps be improved by setting aright these soil deficiencies. Suitable cover crops such as ipil-ipil (*Leucaena glauca* [L.] Benth.) and other leguminous plants which do not harbor diseases and pests that attack citrus may aid greatly in improving the condition of the orchards.

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[2] Parker, E. R. 1935 Experiments on mottle-leaf by spraying with zinc compounds. The California Citrograph. *20*, No. 4, pp. 90, 106, 107. Figs. 1. 2.

Anthracnose fruit spot.—This disease is commonly found on pummelo fruits in Bukidnon. It was observed that it attacks the fruits in all stages of development, whether newly-set, (Plate 2, fig. 1) immature or mature. The affected fruits, especially the older ones, generally bear few lesions which are sunken, circular and of orange cinnamon color.[3] The incipient spots measure about 5 millimeters in diameter while the larger and older ones up to 40 or more millimeters. The spot is sometimes accompanied by an exudation of a clear, yellowish liquid which if not washed off by rain, hardens on the surface of the fruit (Plate 2, fig. 2), into a transparent mass, ochraceous-buff to ochraceous-tawny in color. Under favorable weather conditions pinkish masses of fungous fructifications, which sometimes appear in concentric rings, develop on the spots (Plate 2, fig. 3). During a prolonged drizzly or rainy weather the spots spread rapidly and may cover the entire fruits. On the other hand, prolonged dry weather inhibits the development of the spots and causes them to become hard and dry. On sectioning a number of badly affected fruits freshly picked from the tree it was observed that the disease attacks not only its rind but also its locules and core. Fruits which have been badly attacked by the disease fall off. The shedding of the fruits is frequently hastened by the invasion of maggots (larvae of fruit flies), beetles and other insects which enter through the rotted portions of the spotted fruit. Although common in Bukidnon, the anthracnose fruit spot disease has not been observed to be alarming in that place.

The disease is caused by the *Gloeosporium* stage (Fig. 1) of *Glomerella cingulata* (Stonem.) S. and v. s. The same organism is probably the cause of the blighting of avocado in certain places in Bukidnon.

The occurrence of anthracnose spot on pummelo fruits in Bukidnon seems to be related with the somewhat semi-temperate climate and with more or less abundantly uniform monthly rainfall in that region. In California the same disease was found favored by temperature ranging from 16 to 21°C.[4] This varia-

[3] The colors indicated here are those of Ridgway's Color Standards and Color Nomenclature. Washington (1912).

[4] Fawcett, H. S. and A. Atherton Lee. 1926. Citrus disease and their control. First edition. McGraw-Hill Book Company, Inc. New York, 582 pp.

tion of temperature lies practically within the range existing in Bukidnon; hence, the prevalence of the disease in that place and its scarcity or absence in the warmer regions.

FIG. 1. Camera lucida drawings of mycelium (*a*) and spores (*b*) of anthracnose spot organism on pummelo fruit.

Since the anthracnose spot disease occurs usually on fruits of weakened trees, greater attention should, therefore, be directed to the growing of vigorous trees. In controlling this disease the first thing that should be done is to eliminate the sources of infection by picking the dried or diseased fruits and twigs and then burning them. Serious infection of the fruits may be prevented by spraying the trees three times with Bordeaux mixture (Bluestone, 2 kilos; quick-lime, 2 kilos; water 200 liters); first, immediately before flowering; second, when most of the fruits have set; third, 3 weeks after the second application.

ILLUSTRATIONS

PLATE 1

FIG. 1. Mottled leaves of sweet orange. Note the chlorotic parts of the leaves between the lateral veins. About ¾ natural size.

2. An advanced case of mottle-leaf on sweet orange. Note defoliation and dying-back of the twigs. About X 1/18.

PLATE 2

FIG. 1. Newly-set pummelo fruits attacked by anthracnose spot. Note the growth of anthracnose spot organism which covers the entire fruit. Slightly more than natural size.

2. Anthracnose spot on premature pummelo fruit. Note the exudation oozing out of the spot. About natural size.

3. A premature pummelo fruit attacked by anthracnose spot. The spots are covered with masses of mycelium and spores of the causative fungus.

TEXT FIGURE

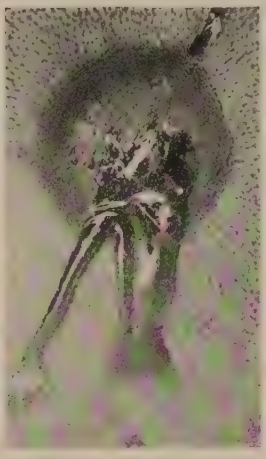
FIG. 1. Camera lucida drawings of mycelium (*a*) and spores (*b*) of anthracnose spot organism on pummelo fruit. About X 1600.

1

2

PLATE 1.

1



2

3

PLATE 2.

THE IDENTITY OF THE COTTON STEM WEEVIL AND PARASITES OF THE CATERPILLAR OF *COSMOPHILA* AND THE COMMON MEALY BUG [1]

By F. Q. Otanes

Of the Plant Pest and Disease Control Division
Bureau of Plant Industry

In a paper on cotton insects (Otanes and Butac: A preliminary study of cotton insects in the Philippines and suggestions for their control) in a previous issue of the Philippine Journal of Agriculture (Vol. 6, No. 2, 1935, pages 159 to 160, Plate 1, figs. 2 and 3) it was stated that the cotton stem weevil was apparently similar, if not identical, to another species, *Phylaitis* sp., which occurs in India and described and figured by Lefroy and Howlet (Indian Insect Life, 1909, p. 389, pl. 27). The weevil was recently identified as *Pempheres affinis* Faust, by Mr. L. L. Buchanan of the U. S. Bureau of Entomology and Plant Quarantine, from specimens sent to Dr. H. Morrison, in charge of the Division of Insect Identification of that Bureau. Mr. Buchanan called attention to the fact that the species also occurs in India and was reported in the Science Reports (page 68, 1928–29) of the Pusa Agricultural Research Institute. The species is listed by W. Schultze in his catalogue of Philippine coleoptera (A Catalogue of Philippine Coleoptera, 1915, Bureau of Science, Manila), based on material collected at Los Baños, Laguna, by the late Dean C. F. Baker (17334, Baker). In this connection it may be stated that a letter has been received from Mr. M. C. Cherian, Government Entomologist, Coimbatore, South India, saying that *Pempheres affinis* Faust is rather serious to cotton there. He added that some hymenopterous parasites have been reared from the weevil in India and inquired whether parasites of the species have been observed in the Philippines. So far as known, no parasites have been reared locally as yet from this species. Because of the fact that the larvae work in the stems of cotton plants, the insect would be very difficult to control should it become prevalent in a locality. The weevil is therefore worthy of detailed study.

The hymenopterous parasite of the caterpillars of *Cosmophila erosa* Hubn., described and referred to as *Euplectrus* sp. in the

[1] Read before the Third Philippine Science Convention, held at Manila in March, 1935.

same paper (page 154, Plate 10, figs. 1 to 4) was identified as *Euplectrus manilae* Ashmead, by Mr. A. B. Gahan of the U. S. Bureau Entomology and Plant Quarantine from specimens sent to Dr. Morrison. Mr. Gahan has also identified the three species of parasites of the common mealy bug, *Ferrisia virgata* Ckll., (page 162), as *Leptomastix longipennis* Mercet, *Holanusomyia pulchripennis* Girault, and *Blepyrus insularis* Ashmead.

ERRATA

VOLUME 6, NO. 3

Page 272, first paragraph, fourth line. Read *ovales* instead of *vales.*

Page 273, first paragraph, eighth line. Omit comma (,) between the words breadth index.

Page 278, third paragraph, fourth line. Read *curly* instead of *surly.*

Page 281, second paragraph, fifth line. Read *both plots* instead of *both dots.*

Page 283, first line. Read *marked* instead of *market.*

Page 283, second paragraph, tenth line. Insert *coarse* to read *and these are coarse to be considered as wrapper leaves.*

Page 283, second paragraph, twenty-fifth line. Change *plus* (+) sign to *division* (÷) sign.

Page 284 and page 285. All *plus* (+) signs and *multiplication* (×) signs between figures in the table should be changed to *plus* and *minus* (±) signs.

Page 287, footnote (1) *EE* change to *FE,* being abbreviation for fairly erect in the table.

Page 287, footnote (2) *Swo* change to *Sw,* being abbreviation for swollen in the table.

Page 289, fourth and fifth paragraphs. All *plus* (+) signs between figures should be changed to *plus* and *minus* (±) signs.

Page 289, fifth paragraph, sixth line. *Hx*F4-14 should be changed to *Ix*F4-14.

Page 290, all *plus* (+) signs between figures should be changed to *plus* and *minus* (±) signs.

Page 303, table heading. Read *computed* yield instead of *completed* yield.

Page 306, third line. Read *strain tests* instead of *certain tests.*

Page 307, seventh paragraph, first line. Read *selections* instead of *selection.*

Page 307, seventh paragraph, third line. Change *this* to *these.*

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